The Dock & Harbour Authority

No. 433. Vol. XXXVII. NOVEMBER, 1956 Monthly 2s. 6d.

Libya Clears up War's Debris

Dredges mud and mortar-bombs the Priestman way

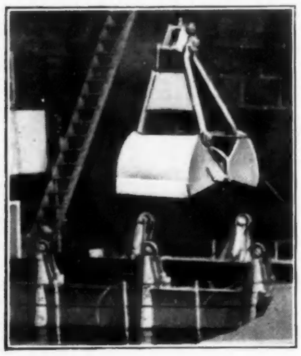
The North African Ports received their full share of military attacks during the late war and, as the tide of battle swept back and forth, its debris accumulated as neither side was able or willing to carry out dredging operations.

Faced with the problem of dredging its harbours the newly formed Government could not, for economic reasons, purchase its own equipment, but the Admiralty were able to offer assistance by sending one of their grab dredgers to carry out a certain amount of work in Tobruk and other ports.

As soon as circumstances permitted the Libyan Government allocated funds for the purchase of dredging equipment and without hesitation chose grab dredgers.

The wide variety of materials, from mud to mortar shells and from broken rocks to bombs, are all good reasons for this choice as no other type of dredger could, economically, handle them.

Priestman Brothers Limited of Hull were accordingly commissioned to supply a Single-Screw Diesel-driven Grab Hopper Dredger for service in the Libyan ports on the Mediterranean coastline, and in turn commissioned the well-known Leith shipbuilders, Henry Robb Limited, to build the vessel; themselves supplying the basic dredging equipment.



The vessel, the Annahda, is of the single flush deck type arranged with machinery aft, the hopper approximately amidships and the dredging crane forward.

The Priestman Grab fills the 275-ton hopper in 88 minutes with a wider variety of spoil than could economically be handled by any other type of dredging equipment.

The dredging crane is of the Priestman No. 50 size, driven by a 100 b.h.p. diesel engine and operates either a 70 cu. ft. Mud, a 55/44 cu. ft. Sand, or a 32/28 cu. ft. Wholetine Rock Grab at depths down to 50-ft. 0-in. below water-level.

Principal Dimensions of the "Annahda."

Length between perpendiculars ...	...110′ 0″	Draft loaded, mean ...	9′ 0″
Breadth moulded	... 29′ 0″	Hopper capacity, tons	275
Breadth overall	... 30′ 6″	Oil fuel capacity, tons	20
Depth moulded	... 10′ 6″	Engine b.h.p. ...	420
		Engine r.p.m. ...	320

On trials the 275-ton hopper was filled in 88 minutes from a depth of about 30-ft. 0-in. in a mixture of mud and shells.

The main propelling machinery consists of a Crossley two-stroke cycle oil engine developing 420 b.h.p. at 320 r.p.m. and on trials a speed of 9.33 knots was attained against a contract speed of 8.5 knots. The deck machinery is all electrically driven with the exception of the steering gear which is hydraulically operated. Two auxiliary engines are situated in the engine room each driving a 15 kw. generator and the necessary air compressors and general service pump. An electrically-driven fuel oil transfer pump is also fitted.

Accommodation is provided for a total of 11 men, part of this being arranged forward and part aft on the main deck. A saloon and galley are built aft alongside the machinery casings and the necessary toilet facilities are provided.

THE PRIESTMAN SYSTEM

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The Dock & Harbour Authority

An International Journal with a circulation extending to 85 Maritime Countries

No. 433

Vol. XXXVII.

NOVEMBER, 1956

Monthly 2s. 6d.

Editorial Comments

The Port of Dar es Salaam.

During the last few years work has been progressing steadily on the East African ports in order to provide them with adequate facilities to keep abreast of the ever-increasing economic expansion of the territories since the conclusion of the Second World War. Two years ago the port of Mtwara was opened to accommodate the trade of the South Province. Shortly after, the new lighterage quay was completed at the port of Tanga, and at Mombasa the further expansion of port facilities is still proceeding. Last month saw the opening of the new deep water quay at Dar es Salaam by Her Royal Highness, the Princess Margaret. A description of the facilities of this port forms the subject of our leading article this month.

With the completion of this modern ocean terminal the East African Railways and Harbours Administration have supplied Tanganyika and the Belgian Congo with adequate deep-water facilities to satisfy their needs for some time to come. Although earlier schemes for the construction of deep water berths had been considered for Dar es Salaam both by the Germans during their occupation, and later by the Tanganyika Government, these plans were never put in hand, due chiefly to the intervention of the First World War and later to the trade recession of 1930. Until comparatively recently, all the development that did take place was a gradual and haphazard expansion of the old lighterage port. In spite of this, however, in 1955 Dar es Salaam handled nearly a million tons of cargo and 50,000 passengers. This fact reflects great credit on the port authorities and those concerned in working the port with its cramped and handicapped facilities.

The pressing need for really effective expansion of the port was realised in 1948 with the tremendous growth in traffic caused by the inception of the ill-fated Groundnut Scheme, and a Committee was appointed to examine whether a deep-water installation could be constructed at Dar es Salaam or whether a new site should be selected elsewhere. After study, the present site was shown to have great possibilities, both for immediate use and for ultimate major expansion, not only for Tanganyika but also for the Belgian Congo. Indeed the Government of the Belgian Congo were immediately interested in the project and showed their faith in the development of the territory, and their willingness to co-operate, by agreeing to contribute towards the cost of the scheme which included a new headquarters for Belbase — the Belgian enclave in the port. This is an encouraging example of international co-operation in the economic development of Africa.

The East African Railways and Harbours Administration are to be congratulated on the many improvements effected at their ports by the installation of up-to-date facilities.

The Vexed Problem of Dock Labour.

This year's presidential address to the Institute of Transport by Mr. Francis H. Cave, general manager and secretary of the Mersey Docks and Harbour Board, was a stimulating contribution to the problem of improving the present unsatisfactory employer—employee relationship in the port industry. Extracts from his address, together with correspondence received subsequently, will be found on a following page. The views expressed are interesting and informative.

In his address, Mr. Cave put forward some tentative suggestions for reducing a large measure of casual labour at the docks by increasing the number of weekly workers and augmenting this permanent force during peak working periods by calling upon the services of trainees. His proposals will be regarded by many as impracticable and already they have been the subject of much discussion and some adverse comments. Nevertheless, in view of his many years experience in the industry, his remarks merit careful study.

There is no doubt that the present dock labour scheme has many failings, and every endeavour should be made by both the Employers and the Unions to effect an improvement. As Mr. C. T. Brummer said when proposing a vote of thanks at the conclusion of Mr. Cave's address, "The special difficulties of the ports are part of a wider national problem to which we have yet to find the solution. . . The attitude of dock labour towards modern methods of handling, and the insistence upon maintaining outdated and restrictive practices, are proving serious handicaps to any hope of early improvement . . . Memories of the black days of casual labour die hard. What Mr. Cave proposes is no less than a new deal for the dockers, a new approach that would raise their morale by making them feel that they really "belong" to regular employers, rather than being the mobile assets of the Dock Labour Board."

In our view, the time is now opportune to review the problem and to impartially discuss the pros and cons. We have therefore arranged to publish in following issues further articles expressing divergent opinions. It is hoped they will be constructive, and if by so ventilating the subject one or two of the present difficulties are removed, a useful purpose will have been served.

Freeing Navigation Lanes from Ice.

A scheme is now under construction to keep the port of Västerås on Lake Mälar in Sweden open to navigation during the winter months. The project would link Västerås with the port of Södertälje, some sixty miles away on the Baltic, by means of compressor-fed perforated neoprene pipes placed on the bottom of the lake. The compressed air whirls the warmer bottom water towards the surface and melts the ice, at the same time preventing further ice formation. Preliminary calculations indicate that the project would be a paying proposition, eliminating costly ice-breaking. The lake is deep and relatively free from water currents and would be well suited to such an installation.

For the last few years, this method has been used successfully in ferry lanes and in shipyards to prevent the formation of ice, and an experimental plant was tried out in the port of Västerås during the winter of 1955. This installation consisted of 1,000-ft. of plastic pipeline, perforated by small holes bored at 33-ft. intervals in the main length and at 16-ft. intervals at the end farthest from the compressor station. The compressor had a capacity of 16 cu. ft. per minute and the water depth was approximately 50-ft.

When the pipeline was first laid in position, the thickness of the ice was about 2-ft. After it had been in operation for twenty hours, open ice holes appeared and, twenty-four hours later, holes of 30-ft. in width had formed, leaving a practically free lane of water 30 to 40-ft. wide. It was established that this lane remained

Editorial Comments—continued

open for as long as air continued to be fed, but as soon as the supply of air was discontinued a layer of ice began to form. This method of combatting the formation of ice proved to be reliable even during the unusually severe winter of last year, and it was subsequently discovered that one-half the compressor capacity originally used would be sufficient for identical conditions.

A committee of fourteen engineering and economic experts has now been formed at Västerås to study further the projected scheme for Lake Mälar which, if it is adopted, will make an appreciable difference to the port.

In view of the many ports in Northern Europe whose trade is governed by the weather, it would appear that, should this method of preventing the formation of ice be found commercially practicable, it could profitably be applied in other countries. Indeed, experiments have been carried out in Canada and these are creating wide interest.

The Problem of Large Tankers and Oil Storage.

An article in this issue deals with the topical problem concerning the increasing draft of modern tankers and the difficulty of providing them with adequate port accommodation. The author suggests that Foynes Harbour in Ireland should be developed to become an entrepôt for Northern and Western Europe, especially for the import of oil. His views may be regarded as partisan; nevertheless they deserve consideration, especially in view of the blocking of the Suez Canal and the prevailing unrest in the Middle East. This is hampering the transport of oil from that area and may ultimately result in the employment of many super-tankers for conveying oil from other sources.

The suggested plan for the underground storage of oil is novel and its success depends entirely upon the geological conditions being suitable. Whether this would be so, can only be decided after careful research but, provided that there are no fissures of any magnitude, the scheme appears to be practicable.

It is interesting to observe that details were published recently of a similar scheme for underground oil storage in Sweden. According to reports in the press, work is at present in hand at the Port of Sundsvall on the Gulf of Bothnia to enlarge the port's system of rock cisterns for the storage of oil. The first cistern was comcompleted in 1952 and is claimed to be the first to be constructed in Sweden. Known as the "Viaco" Cistern, this new method of storing oil involves the use of old mines or specially blasted rock chambers. The oil rests on an adjustable bed of water and is prevented from leaking away by the pressure of the water in the surrounding subsoil. Apparently, the system has already been patented in several countries.

Proposed Development of Milford Haven.

Another suggestion on somewhat similar lines to the mooted Foynes Harbour plan concerns the construction of extensive oil handling facilities at Milford Haven, on the Welsh coast. Ambitious plans for the development of this area of Pembrokeshire have been under consideration for some time past, and latest reports indicate that a scheme estimated to cost between £13 to £15 million has been placed before the Prime Minister and referred by him to the Minister of Transport. If adopted, the scheme would provide accommodation for the largest tankers in the world.

At the present time, except for Fawley, Isle of Grain and Grangemouth, there is nowhere in Europe where 60—100,000 ton tankers can discharge, and there are only two dry docks large enough to service such tankers and these are used to capacity. It has been decided to investigate the question of one dry dock (possibly two later), four wet berths and two discharge piers, with modified existing works and new shops capable of handling repairs.

It is believed by the C.A.S. (Industrial Developments) Ltd., the group which have submitted the scheme to the Government, that Milford Haven could well become the greatest oil port in Europe. Their objective is an integrated Milford Haven development, where the combined planning, and knowledge of the Milford Dock Company's consultants, the C.A.S. group consultant and the technicians of the oil companies and tanker owners will result in the construction of the most efficient oil dock installation in the world and one which can, in fact, become the main distribution centre for Europe's oil.

The British Petroleum Company have already announced a plan to build a £5 million tanker terminal at Popton Point, on the shore opposite Milford Docks. It is planned that a pipeline will carry oil from this point to refineries at Swansea, nearly 60 miles away.

The Esso Petroleum Company have also bought land near Milford Docks and another oil company is investigating the possibilities of exploiting the natural advantages of this deep water inlet. In addition, there is a possibility that an atomic power station will be sited in the vicincity.

If the scheme is approved by the Government, it will be necessary to institute some form of overall authority, in order to ensure that the various development plans by the different oil companies are co-ordinated under one head.

Port Education Scheme.

The Annual Report of the Institute of Transport on the examinations for Port Workers, 1955-56, shows that the total number of students enrolled was 524, of whom 307 took the examinations and 282 secured Certificates. These figures are less than those for last year but a scheme which attracts over 500 students is still one of considerable importance.

The scheme is now entering its sixth year and it has deservedly become an established feature of the port industry. We should like to see an increasing number of enrolments but under present conditions it is difficult to be optimistic. Many dock workers are elderly and have probably passed the stage when they will take up classes and examinations. The impact of over-time and of the counter attractions of the modern world must affect the entries for these classes. All in all, the classes have done well and with encouragement from Managements, Unions and the National Dock Labour Board, there is every hope that they will develop and attract the younger men in particular in the industry.

Proposal for West Coast Seaport for Rhodesia.

It has recently been reported in the South African press that, as a result of an approach by the Portuguese authorities, the Government of the Federation of Rhodesia and Nyasaland has agreed to examine the technical aspects of a railway line linking the Southern Angola port of Mossamedes to the Rhodesia Railways. It has been stressed, however, that this is in no way a commitment to construct such a railway.

Despite the enthusiasm of some members of the Federal House of Assembly, who seem confident that a West Coast Railway might well be financed from outside Rhodesia, it is a debatable point whether a West Coast port would in fact be of more value to the Federation than the present ports on the East Coast of Africa. It should be remembered that a large quantity of the goods imported into the Federation actually come from areas east of Africa, for instance, wheat from Australia and petrol and oil from the Persian Gulf. Furthermore, East Coast ports have been so much improved in recent years that they will be well able, with the additional facilities provided by South African ports and Lobito Bay, to handle the estimated trade of the Federation for some years ahead.

Plans are already under discussion for the construction of two additional deep-water berths at the Port of Beira, and the port of Lourenco Marques is now able to handle four million tons a year and can easily be extended to handle six million tons. It does not appear therefore that, from a purely economic view, a good case can be advanced for the construction of a West Coast port since so much of the Federation's trade would still move more easily eastwards. Such commodities as copper, lead and zinc might find an easier and faster outlet to the West, but these would only provide some 700,000 tons of exports a year; imports might only total about 180,000 tons.

It is estimated that the cost of a railway, together with rolling stock and improvements to a West Coast port, would amount to £30 million and it is unlikely that the Federation would provide this sum to proceed with the scheme. Should this money be forthcoming from other sources, however, as has been suggested in the Federal House, this of course would make a difference to the consideration of the proposal by the Government.

The Port of Dar es Salaam

Completion of New Ocean Terminal for Tanganyika

(Specially Contributed)

THE history of Dar es Salaam can be said to have begun in 1862 when Seyyid Majid, the Sultan of Zanzibar, decided to build a town on the shores of the bay inhabited only by native fishermen. He named the bay in which he hoped to create a new centre of trade "Dar es Salaam"—or "The Haven of Peace." In 1887 Carl Peters occupied the bay for the German East Africa Company. With the Arabic influence gradually receding to Zanzibar, Dar es Salaam increased in importance and in 1891, coincidental with the German Government taking over the administration from the German East Africa Company, the first Governor of the territory took up his seat at Dar es Salaam. The town then became the capital of the territory in place of the old slave port of Bagamoyo, about 40 miles northwards, and with the expectancy of increased shipping activity buoys were laid in the harbour and the lighthouse on outer Makatumbe island was erected. At the turn of the century a dockyard was constructed for the building, maintenance and repair of small craft engaged in harbour operations.

In 1905 the building of the railway from Dar es Salaam to Morogoro began and a small jetty was built to handle the materials for its construction; later in the year the building of the lighterage quay started. Subsequently the apron was equipped with a low level customs shed, cranes and transporters.

During the 1914-18 war, German East Africa was invaded by Allied forces and Dar es Salaam surrendered to the British in September, 1916. In 1920 at the Treaty of Versailles, the territory became known as Tanganyika—a mandated territory under British administration, and in 1921 an enclave in the Port of Dar es Salaam was leased to Belgium to enable traffic to and from the Belgian Congo to be handled.

Unfortunately investments of capital were not immediately forthcoming and little development took place until after the second World War. In December, 1946, it was announced at the General Assembly of the United Nations that Tanganyika Territory would be reconstituted under U.N.O. trusteeship—Great Britain to continue her administration of the country.

The post-war story of Tanganyika is one of increased production and increased quantities of goods for export. As Dar es Salaam is not only the principal port of Tanganyika, but also handles important transit traffic to and from the Belgian Congo, where similar development has also taken place, it is not surprising to find that there has been a great increase in the amount of cargo handled at the port. In 1939 it totalled 180,000 tons; in 1951 650,000 tons and by 1955 the total tonnage of exports and imports and goods transhipped had reached nearly one million tons.

However, the port was not ideally equipped to handle such large quantities of cargo, as ships were only able to transfer their cargoes by lighters to and from a lighterage quay. In other words all cargo had to be handled twice between the holds of the ships and the shore. The provision of deepwater berths had been considered over a number of years, the original site investigations being carried out between 1927—1933. The trade depression of the 1930's and the outbreak of the second World War prevented further action being taken and it was not until 1949 that it was finally decided to proceed with the construction of two deepwater berths. The Belgian Government also finding it necessary to increase the accommodation in their enclave, decided to pay for the construction of an additional berth.

Designs were then completed by the Consulting Engineers, Messrs. Coode and Partners, London, and a contract for the new berths was placed, in April, 1951, by the East African Railways and Harbours Administration with Messrs. J. L. Kier & Company, Ltd., London. Work was started in the following June.

The site chosen for the berths was, at that time partially occupied by the dockyard built by the Germans. This was demolished and a new marine dockyard has been built threequarters of a mile away well clear of any future port development.

The construction of these berths and associated facilities has cost more than £4 million and the work has taken over five years to complete. As a result Dar es Salaam is now capable of handling 1,500,000 tons of cargo annually without difficulty.

The provision of three deep water berths, now completed, means that ships up to 20,000 gross tons (not exceeding 600-ft. in length or 30-ft. in draught) can come alongside a quay equipped with the most modern cargo-handling machinery, and that goods will be quickly and economically transferred straight from ship to shore.

A combined office for port staff and public firms having business in the port area is to be built on the high ground above the port, just outside the port perimeter fence. At the entrance to the port area a new marshalling yard has been laid out on reclaimed ground

View of new deep water berth looking from the Lighterage Quay (in foreground).

and this yard is, in turn, connected to the existing lighterage area, the oil storage depots and to the main traffic marshalling yard at Ilala.

The Deep Water Berths.

The port is a safe land-locked harbour in the form of a lagoon, with a large creek extending in a southerly direction. The site chosen for the new berths is on the western side of the Southern Creek and about 1,200-ft. from the existing lighter wharf (see Fig. 1).

The new quay wall, a cross section of which is shown in Fig. 2, is 1,824-ft. long with an apron width of 65-ft., and is constructed of concrete blocks, the blocks having been made in a yard adjacent to the site. At one end of the yard was a crushing plant for which stone was brought in by road and rail. The crushed stone and sand were fed into a weighbatching plant and the concrete materials were mixed in a 1 cu. yd. mixer from which the concrete was taken to the moulds in specially constructed skips pulled by diesel locomotives running on Decauville track fixed on a timber gantry. On either side of this gantry carefully levelled concrete plinths had been formed on which the moulds were set up. After being cured for seven days the blocks were taken to the stacking yard where they remained for at least a further 21 days before being used on the works.

Port of Dar es Salaam—continued

A foundation for the wall was prepared by bucket dredger forming a trench, the bottom of which was subsequently cleaned by divers using an airlift. This operation was followed by the dumping of a layer of rubble, 5-ft. thick, on which was set and screeded to level a bed, 6-in. thick, of 2-in. road metal.

On this bed of small stone the blocks were built in slicework at a slope of $67\frac{1}{2}°$, the blocks varying in weight from 9 to 16 tons, each slice being $4\frac{1}{2}$-ft. in thickness and weighing 275 tons. The bottom of the trench was at -41.14 and the top of the slicework at $+5.50$. The blocks were set by a crane which travelled on the top of the finished blockwork and which had a reach of 45-ft.

The superstructure of the wall from $+5.50$ to $+18.00$ was formed of 7 to 1 concrete-in-mass, faced with concrete block ashlar. In the superstructure were accommodated a chase for crane cables and plug boxes, hydrants, oil bunkering chambers and telephone plug boxes. The depth of water provided is 30-ft. at low water and this can be increased to 32-ft. in the future.

Immediately behind the wall is rubble backing and the material for reclamation was taken from the hillside at the back of the site forming an area of 835-ft. deep from the cope line.

A feature of this addition to the port includes the largest transit shed in East Africa—the Tanganyika Shed. With a length of 975-ft. and a width of 150-ft. the shed, which spans berths 2 and 3, provides 146,250 sq. ft. of floor space for cargo handling.

On the same wharf alignment stands Shed No. 1—the Congo Shed—which is within the Belgian Government's enclave at the port. The ground floors of both sheds are flush with the quay apron and each shed has a rail platform on the landward side.

The Congo Shed is double-storied, 420-ft. by 150-ft., and built in reinforced concrete, and was designed for a first floor loading of 3 cwt. per sq. ft. The building is founded on 60-ft. piles driven into the original sea-bed.

The total area of the deep water quay project is 41 acres, 11 acres of which is apportioned to the Belgian enclave. This area contains, in addition to the Congo Shed, an adjoining office block and five acres of stacking grounds.

Each berth is equipped with three 5-ton and two 7-ton portal electric cranes running on a 600 volt D.C. supply with a reach of 65-ft., whilst in the stacking grounds behind the sheds there are similar cranes of 5-ton and 10-ton capacity.

The contract also included the construction of an administration block for the Belgian agency and ancillary buildings, and the dredging of shoals in the harbour and entrance channel to provide 25-ft. at Low Water. This work and the dredging for the foundation of the Quay Wall involved the removal of some 420,000 cu. yds of spoil. The concrete hopper barges were built on site to handle the dredged material as ordinary barges were unobtainable.

General Information

The entrance to the harbour is through a narrow, winding channel, dredged to 25-ft. L.W.O.S.T. through which runs a very strong ebb and flow at periods of spring tides. Pilotage is compulsory.

The Quays.

The new Princess Margaret Quay and the Town Quays are separated by a small creek used for small craft and lighter mooring, which is practically dry at low water. A road, within the boundaries of the port, runs at the back of the creek, connecting the two quays.

Apart from the quayside transit sheds, the Princess Margaret Quay area also contains the port fire station, police station, post office, Queen's warehouse and engineer's yards. The complete port area can be floodlit for night working.

The Town Quay, which has 7 lighter berths, is used mainly for the handling of exports by lighters to ships anchored in the harbour, but large coasters and small ocean going vessels can be

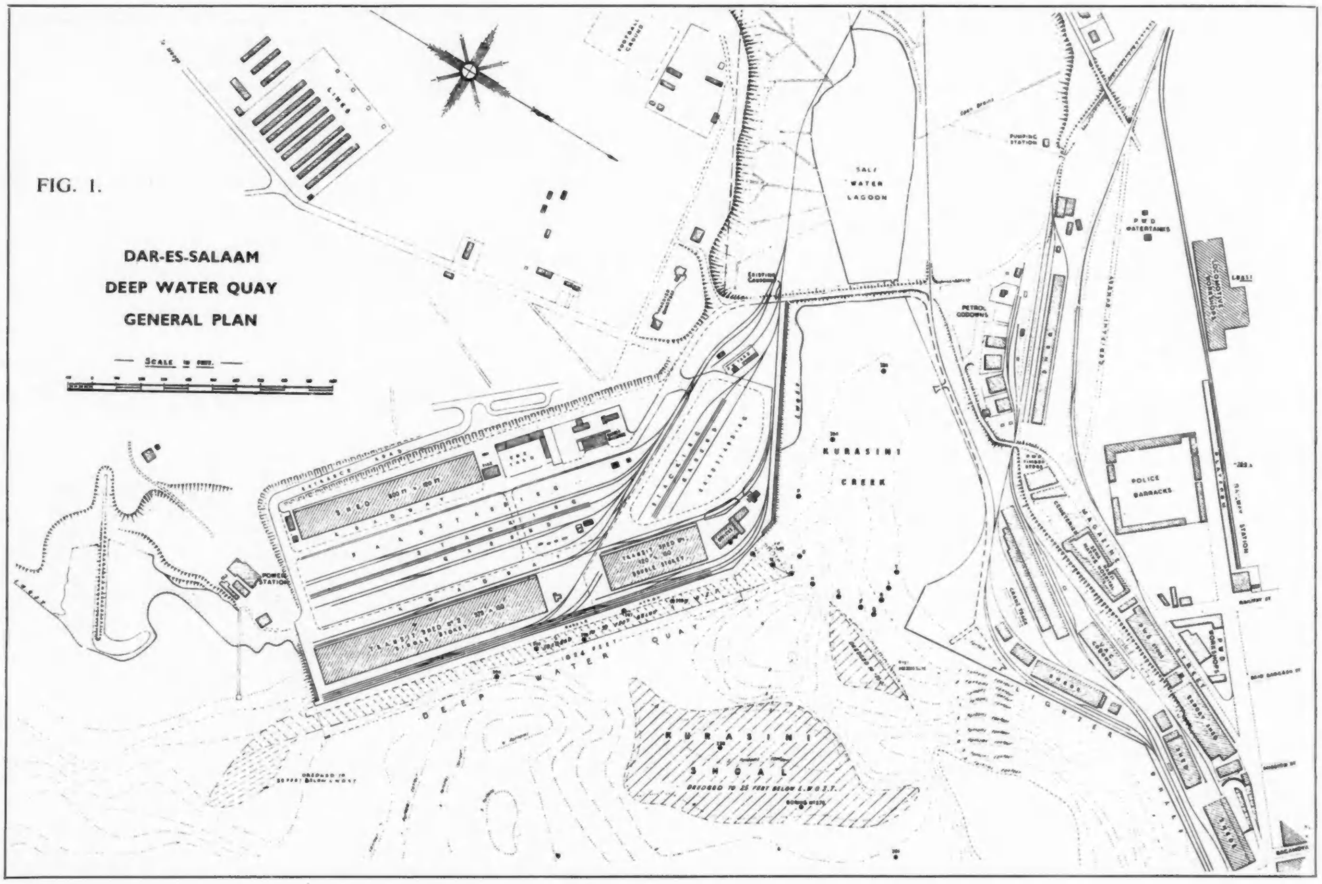


FIG. 1.

Port of Dar es Salaam – *continued*

berthed alongside at berths 6 and 7 where the depth of water is 16-ft.

Passenger Landing Stage.

Situated on the north shore of the harbour, adjacent to but separated from the wharf is the passenger landing stage and the customs examination room. Built in 1927 the pier is a concrete structure terminating in a pontoon, at which motor launches only can be accommodated. Its length (excluding pontoon) is 150-ft. and the depth of water at the pontoon is 10-ft. L.W.O.S.T.

Dhow and Schooner Wharf.

The dhow and schooner wharf consists of a wharf with a wooden "T" shaped jetty, both of which were constructed in 1949. The wharf is used by dhows and schooners operating in the coastal trade and the dhows and booms which arrive from India and the Persian Gulf with the North East Monsoon. The length of the jetty extends north-east from the wharf 275-ft. The "T" head is 150-ft. long where depth of water is 7-ft. L.W.O.S.T.

At the outer anchorage ships of any size and depth can berth. The holding ground is good but the position is subject to swells during the north east monsoons. There are moorings for 11 vessels, the depth of water ranging from 23-ft. to 30-ft.

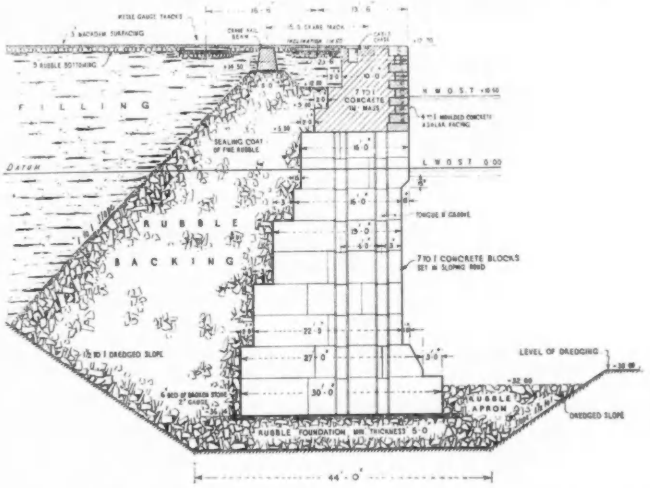


Fig. 2. Dar Es Salaam, Deep Water Quay, Cross-section of Wall.

Imports and Exports

Cargo handling ashore is carried out by The Landing and Shipping Company of East Africa Ltd., contractors to the East African Railways and Harbours Administration. Cargo is handled on board vessels by stevedoring companies.

Cargo transhipped at Dar es Salaam is mainly coastwise cargo from the Southern Province port of Mtwara and consists of locally grown produce.

Imports.

During post-war years imports have far outweighed exports, due to the greatly increased economic development of the territory. In pre-war years, textiles and cotton piece goods were the main imports but to-day machinery and building materials, particularly cement (124,017 tons in 1955) account for the bulk of import traffic, which totalled 673,397 tons in 1955.

Exports.

Sisal is the largest industry of Tanganyika, the territory now being one of the world's biggest exporters of that commodity. The bulk of the sisal shipped from Dar es Salaam (73,786 tons in 1955) is grown in estates within 200 miles of the coast.

Cotton is another important crop, the main areas of cultivation being in the Lake and Eastern Provinces. Cotton production dropped in the latter war years but has risen steadily in the post-

Wall construction in progress using "Fidler's" gear for block setting.

war years and is to-day one of the Territory's most important exports (37,676 tons in 1955).

Cotton oil seed for margarine and soap products, and oil cakes used as cattle food, are valuable by-products of the cotton plant and are exported in large quantities. In smaller amounts, castor oil seed, linseed and sesame are also exported. Oil seed and cake exports totalled 30.954 tons in 1955.

Other exports include beeswax, cashew nuts, coffee from the Belgian Congo, hides and skins, groundnuts, tea, timber, pyrethrum, rice, sugar, grain, kapok, cassava, wattle bark, gum, lead concentrates, soda ash and kyanite. The total exports of all commodities for 1955 amounted to 311,353 tons.

The Belgian Enclave.

The Belgian leased sites in Tanganyika—operated by L'Agence Belge de l'Est Africain, S.A., and known as Belbase—were first created in 1921 as a result of a convention drawn up between Great Britain and Belgium to cater for "the particular needs, as regards access to the sea, of a portion of the Belgian Congo and of the territories whose administration has been entrusted to Belgium." These were the former German territories known as the Ruanda-Urundi, which were entrusted to Belgium at the end of the 1914-18 War. Under the Convention Great Britain undertook to grant

Interior view of 1,000-ft. long, single-storey transit shed serving Nos. 1 and 2 Berths.

Port of Dar es Salaam—continued

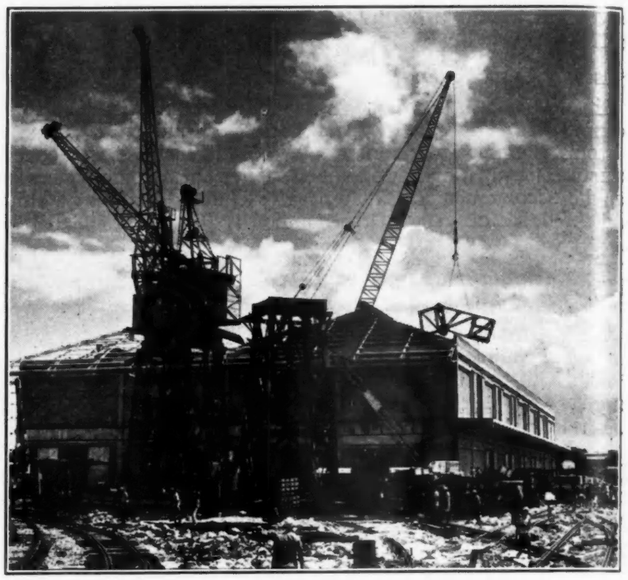
freedom of transit across East Africa by railway, lake, navigable water course or canal to all persons, mails, goods, ships, railway carriages and trucks coming from or proceeding to the Belgian Congo, and Ruanda-Urundi, on a footing of equality to the British. Further, to facilitate the handling of traffic to and from the Belgian Congo the British Government leased sites in the ports of Dar es Salaam and Kigoma to the Belgian Government in perpetuity in return for an annual rent of Fr. 1.

These sites proved sufficient until recent years when the necessity for larger facilities became imminent and in 1951, a new agreement was signed supplementing the 1921 convention. The agreement provided for a site, adjacent to the sites of the two deep-water berths to be constructed for the use of the East African Railways and Harbours Administration, and on which a deep-water berth could be constructed for the use of the Belgian Government. This new site was to be in exchange for the site leased to and occupied by the Belgian Government at that time. It was further agreed that if the volume of the Belgian traffic expanded to such an extent as to require still further extension such facilities would be granted.

The new Belgian deep-water berth will not only offer the advantage of better storage facilities, but will also help to curtail considerably the transit period for goods to the Congo.

Congo traffic through Dar es Salaam and Kigoma reached its peak in 1954 and although there was a slight decline in last year's traffic it is hoped that the new facilities offered will provide an incentive to the Belgian Congo importers and exporters to make more intensive use of the leased sites in Tanganyika.

From 1924 to 1931 considerable tonnages of minerals from the Congo were exported through Dar es Salaam, but this traffic was lost in subsequent years. The recent creation of rail links in the Congo transport system and the development of the railways and harbours in East Africa could mean that a percentage of these exports, which attain many hundred thousand tons annually, will eventually be shipped through Tanganyika. Furthermore, through the extensive development of agriculture in the adjoining territory of Ruanda-Urundi, exports of coffee and other produce are expected to increase considerably during the coming years.



Erecting cranes to serve the new deep water berths.

Marine Pilotage

History of Development and Service

(Specially Contributed)

A SEA pilot is the first or last link on a shipping route to or from a port—his services are enlisted to increase the safety of a vessel's progress through waters usually unfamiliar to the master. No uniform conception exists in the maritime laws of the nations about the position of the pilot, although the opinion predominates that he is merely an adviser to the master, and that the master remains fully responsible for the course and safety of the vessel even when a pilot is on board.

Only a comparatively small group of men are engaged in this work; nevertheless the large volume of legislation relating to pilotage, which has been enacted during the last 150 years is an indication of the public importance of this vital link in our sea service. It is probably also true to say that pilotage has had its fair share of ineffective legislation which has required later amending laws.

The fierce tides and the uncertain weather conditions around the coasts of Britain have made the sand banks and offshore rocks a fruitful ground for disaster and, from early times, the necessity for obtaining the services of a seaman with local knowledge for assisting in the navigation of a ship in the approaches to a port was well recognised.

The earliest form of State recognition appears to have been Royal Charters incorporating Guilds or Associations of Mariners equipped with appropriate powers and privileges. In a maritime nation such as ours, State encouragement in providing an efficient pilotage service seems to be well justified on the grounds that it is in the interests of the public that a service of this kind should be available for the assistance of vessels using our harbours.

As far back as 1369 an organisation of seamen was established as the Trinity House of Hull, its principal purpose being to ensure that only properly qualified and licensed pilots should engage in the work of piloting in and out of the district under their jurisdiction. Other similar organisations were established, taking the names of the Trinity House of Leith, of London, of the Cinque Ports and of Newcastle. These associations were in due course incorporated and, although jurisdiction and powers have to some extent changed, these bodies exist to-day to carry on the tradition of "safe pilotage." The old Charters laid considerable emphasis on the need for preventing "indiscreet and unskilful persons" from imposing their services on the guileless mariner from across the seas eagerly searching for the pilot to relieve his apprehension and conduct him to a safe anchorage. There can be little doubt that there was a real need to protect mariners from roving would-be pilots for, as recently as 1850, a perhaps misguided ecclesiastic, when giving evidence before an Inquiry into some of these practices and whilst supporting the cause of a group of unqualified men, was asked whether he knew that there existed in his parish a printing press which turned out pilots' licences which purported to be the real thing and which could be purchased for a modest sum.

These unlicensed activities were not without risk to the pilot or "lodesman" as he was sometimes called. The Black Book of the Admiralty has it that,

> "It is established for a custome of the sea that yf a shyp is lost by default of the lodesman, the mariners may yf they please bring the lodesman to the windlass or other place and cut off his head without the maryners being bound to answer before any judge."

The irregularities and inadequacy of the attempts at codification came under the searching and energetic mind of Samuel Pepys who, as Master of Trinity House, effected reforms which (a) made all foreign vessels in certain waters subject to compulsory pilotage, and (b) introduced a rule that all pilots must be licensed by Trinity House. To this day the Trinity House at Deptford, London, is the principal licensing Authority in Great Britain for, apart from the London district, it also exercises jurisdiction over more than 30 outports as far distant as Barrow and Ilfracombe. It also has power to issue deepsea licences.

During the 18th century, the obligation to employ a properly

Marine Pilotage—*continued*

licensed pilot was extended to all vessels (with some minor exceptions). In some cases, such as Boston and Liverpool, this was achieved by Local Acts whilst in other ports some form of compulsory pilotage was already in force by custom.

In 1836, after a searching enquiry, an Act was passed purporting to consolidate and amend the Law relating to pilots and pilotage. At this time, compulsory pilotage prevailed in all the principal ports of the Kingdom. This was a period of general reform and the Royal Commission was strongly impressed by the scattered nature of the organisation and the variety of bodies to which the appointment and government of pilots had been entrusted. Its Report recommended the repeal of all previous Acts relating to pilotage and further proposed to sweep aside all existing laws, regulations and rates, and to substitute the London Trinity House as a Central Body, with power to make bye-laws and rates for all ports and pilotage districts. The failure to implement these far-sighted recommendations made more than 100 years ago is sometimes regarded as having resulted in a system—or want of a system—in which unnecessary legislation, litigation, expenditure and waste of man-power have been of too frequent occurrence.

The advance of the industrial age during the 19th century and the development from sail to steam found the system of pilotage a source of delay and loss at a time when speed and quick turn-round were becoming increasingly important. In a world of awakening competition the pilotage facilities were criticised for their inadequacy. Select Committees examined the position in 1870 and again in 1888, whilst local inquiries were held in most principal ports. The subject of pilotage was dealt with in the Merchant Shipping Act of 1854 and again in 1894, and although these Acts in turn were consolidating Acts, no attempt was made to implement the recommendations of the 1836 Commission, namely to repeal all local acts, byelaws, etc., and to introduce a general measure to have force throughout the Kingdom. The ambiguities and inconsistency between general and local legislation remained, although by 1911, when the next and last general review of pilotage law was made, the Board of Trade and Trinity House, London, had emerged as the important Central Authorities for pilotage matters.

The Merchant Shipping Act of 1889 provided for the direct representation of pilots and shipowners on a Pilotage Committee and the Merchant Shipping Act of 1854 and that of 1894 conferred complete powers of regulation of pilots by byelaws framed by a local authority, subject to confirmation by the Privy Council.

Whenever pilotage has come under review, the subject of compulsory pilotage has always presented one of the major problems, and wide swings have taken place in contemporary thought and in the recommendations made, but few changes have in fact resulted. By compulsory pilotage is meant, the obligation upon the master of a vessel to avail himself of the services of a licensed pilot when formally offered to him for the piloting of the vessel within the District for which the pilot is licensed, under a maximum penalty, enforced by civil process of charging double the pilotage. None of the legislation seeks to lay down a principle which might assist in determining whether compulsory pilotage should or should not prevail in any particular Pilotage District. Each Act in turn has expressly retained the "status quo," although a procedure has been set out for making pilotage free if agreement can be reached to do so.

In some cases the position has been preserved not because of any real demand or need for pilots, but largely in order not to extinguish a means of livelihood for pilots who have chosen this way of life and whose stock in trade or skill has no marketable value elsewhere. This latter point has been to some extent dispelled by the interchange which took place during the war years when men who had been London pilots were sent to help out the pressure of work in the Clyde, as the enemies' attacked changed the pattern of our ports. Also, on "D" Day, pilots from several Districts were co-opted to help out the heavy concentration of shipping which had to be sailed from south coast ports.

Compulsory pilotage was closely examined by the Select Committee of 1860 and strange anomalies and some conflict and confusion of jurisdiction were revealed. One result of the inquiry was the Bristol Channel Pilotage Act of 1861, which authorised the setting up of separate pilotage authorities for Cardiff, Newport and Gloucester, which had up to that time come within the Bristol Pilotage District.

The Commission was almost unanimous in declaring in favour of free as opposed to compulsory pilotage, and again in 1870 a Bill was examined by a Select Committee who recommended that compulsory pilotage should be abolished altogether, but the minority won the day by preferring a less sweeping change, and it was left to the properly constituted local Pilotage Authority as being in touch with and representative of the trade and commerce of the District.

In considering compulsory pilotage, the liability of the shipowner whose ship had been damaged or had done damage whilst in the charge of a pilot was always a bone of contention. Views have been sharply divided on this issue. Prior to 1812 ships doing damage were held responsible, although compulsorily in the charge of a pilot. The Act 52 Geo. III c.39 however exempted the shipowner from liability in such circumstances and when put to the test, the provisions of this Act also exempted a master who employed a pilot when he was under no obligation to do so.

The Merchant Shipping Act of 1854 and the later Act of 1894 confined this immunity to cases in which the employment of a pilot was compulsory by law. The Committee which sat in 1870 regarded the shipowners' immunity as one of the strongest arguments against the principle of compulsory pilotage and yet it seemed unjust to hold the shipowner or master liable for the default of a pilot he was compelled to employ. This was the Committee which recommended the abolition of compulsory pilotage. By 1888 the shipowning interests in this country had become very powerful and the vast interests involved may have weighed with the Select Committee of the House of Commons which examined pilotage in that year, and they expressed the view that the principle of compulsory pilotage was best left to the Local Pilotage Authorities. This Committee did come out strongly in support of the Rule that the master of a vessel, even when a pilot is on board, should continue to be responsible for the conduct and navigation of his vessel. Shipowners, however, continued to be immune until the passing of the Pilotage Act, 1913, or soon after when S.18 was implemented in 1918, and the position has been thoroughly examined and upheld through the courts to the House of Lords in the case of Workington Harbour Board v. s.s. Towerfield (1949). So the position is that since 1918 the defence of compulsory pilotage is of no avail to the shipowner.

Whilst the liability of shipowners and also the pilot has been the subject of frequent examination, it was not until the famous Dundee Harbour Case (1919) that the Statutory liability of a Pilotage Authority was fully recognised. The House of Lords in this case found that the Harbour Trustees as Pilotage Authority were negligent in not taking reasonable steps to secure the attendance of pilots for vessels coming up the Tay. The damages awarded were very heavy and the award brought out more vividly than ever before that a Pilotage Authority as such possesses no funds to meet such a situation. Its revenue is in the form of pilotage dues, from which the pilots are remunerated and the pilot vessels maintained, leaving little or no balance at the end of the year.

In 1936 the Pilotage Authorities' Limitation of Liabilities Act was passed and this limits a Pilotage Authority's liability to £100 per licensed pilot, providing the cause of action is not due to any fault or privity on the part of the Authority as such. The Act also makes it clear that the Funds which a Pilotage Authority may have access to in some capacity other than that of a Pilotage Authority (such as a Conservancy Authority) cannot be raided for meeting claims made against the Pilotage Authority.

As a byelaw making body, the Pilotage Authority has the onerous duty of ensuring that the byelaws are carried out, a task which is by no means easy owing to the nature of a pilot's terms of service (as a self-employed person) and the independent and scattered places in which he operates. In addition to the protection afforded by the 1936 Act, some form of insurance cover would seem to be a prudent policy.

The essence of a pilotage service is that a properly licensed pilot shall be available and offer his services at the proper time and place. If the master of a vessel is unable to obtain these services when he arrives off a port, he is at liberty to bring his ship into port without a pilot. If by so doing, he damages his vessel, or

Marine Pilotage—continued

some other vessel, his owners may take the view that this damage would not have occurred if a pilot had been available, and that the Pilotage Authority have failed in their duty to provide one and are therefore liable.

An interesting situation arises in the event of a pilots' "strike." It might be held that a Pilotage Authority in order to fulfil its obligations should licence other qualified navigators to keep the service available. A Pilotage Authority is, however, declared to be in no way responsible for the acts or defaults of a pilot whilst performing pilotage duties.

The duty of administering and managing pilotage matters continues to be entrusted to bodies which vary widely in character. Under the definition of Pilotage Authority there are four broad groups: (1) The Trinity Houses; (2) Harbour Authorities; (3) Municipal Corporations; (4) Pilotage Boards, Trusts or Commissioners. The Trinity House of London is by far the most important Authority and the Pilotage Committee consists of Elder Brethren, Shipowners and Pilots with a Principal Officer in charge of the pilotage department. The other functions of Trinity House as the General Lighthouse Authority are conducted quite separately. The Trinity House of Newcastle controls some of the ports on the north east coast, whilst in 1907 the main portion of the Pilotage jurisdiction of Hull Trinity House was transferred to the Humber Conservancy Board, acting as a Pilotage Authority. The other pilotage authorities in England and Wales, about 27 in number, are evenly divided between Harbour Authorities and Pilotage Boards, Trusts or Commissions. Bristol is perhaps unique as the only port in England and Wales in which pilotage matters are entrusted to the Municipal Corporation.

Liverpool, Manchester and the Humber area are among the larger ports where the Pilotage Authority is also the Harbour Authority. These Authorities usually delegate pilotage matters to a Pilotage Committee constituted under a Pilotage Order for the District. In theory, a Harbour Authority has an interest in the maintenance of an efficient pilotage service, and whilst this may be the general rule, it may occasionally happen that the legitimate interests of pilots may be overlooked if the control of pilots is vested in the hands of persons directly interested in the trade of the port or in persons owning the docks or tugs. Good and efficient pilotage service is provided by all four of the groups mentioned, but it has sometimes been contended that probably the most satisfactory type of controlling body for pilotage is one on which shipowners and pilots are represented and also a group of practical nautical men with local experience.

The far-sighted enquirers in 1836 expressed a firm agreement in recommending a Central Controlling body for all pilotage in the U.K. and a contemplation of the contemporary pilotage scene, with all its anomalies, compulsory where it seems to be unnecessary, non-compulsory where it seems almost imperative, requiring a foreign-going Master Mariners' Certificate in one place and little more than a boatman's experience in another place, prompts the thought that whilst the system, such as it is, does work and in some cases extremely well, it may be time to review this service, which after all is a public service, so that the incoming vessel may know that the man who boards to pilot her to a safe berth belongs to a group of professional men, whose standards are the same and of the highest.

Pilotage to a navigator is an attractive side to his job. It has interests and problems to stimulate, and each vessel safely docked leaves a sense of achievement. There are less than 2,000 pilots required to serve all the ports in the country and there can be little doubt that a Central Pilotage Authority setting suitable standards and able to negotiate reasonable rewards would recruit a team of first-class men from the flower of the sea service. The pilot's position would improve.

This short summary of the history of pilotage in our ports will indicate that it is a subject of national importance which has been, and still is to some extent, bedevilled by a tenacious conservatism and reluctance to change, by restraints which have whittled away the effects of legislation, which by its abundance and inconsistency and half-hearted approach to the problem has done little to iron out a branch of empoyment so ridden with anomalies inherited from bygone days.

(To be continued)

Notable Port Personalities

No. LXIII—Mr. Francis H. Cave, M.Inst.T.

Mr. F. H. Cave has been General Manager and Secretary of the Mersey Docks and Harbour Board since March, 1954. He entered the Board's service in August, 1926, as Assistant to the Chief Traffic Manager and 11 years later was appointed Chief Traffic Manager, a post which he occupied throughout the 1939-45 war when he and his staff were responsible for the clearance of dock quays and the rapid despatch of cargo through the port. He was a member of the Port Emergency Committee and a Chairman of its Sub - Committee appointed to deal with the allocation of transport. In 1946 he was appointed Deputy General Manager of the Board.

Francis H. Cave
President of the Institute of Transport

Mr. Cave served in the Royal Flying Corps in the 1914-18 war and subsequently the Royal Air Force and he has been closely concerned with Territorial Army and R.A.F. affairs, having been Chairman of the Finance Committee of the West Lancashire Territorial Association for a number of years. He has travelled extensively in the United States, Canada and on the Continent to study port design and operation.

Mr. Cave was this year elected President of the Institute of Transport and also Chairman of the Executive Committee of the Dock and Harbour Authorities' Association, a dual honour which has not previously been bestowed upon one man.

Development of the Port of Bangkok.

Bangkok, which is located 30 miles up the Chao Phya River, is the only large port of Thailand and handles most of the country's external trade. In 1950 the International Bank for Reconstruction and Development granted a loan of $4,400,000 for the development of the harbour. This was to help finance the dredging of a navigation channel at the mouth of the river through a sand bar, which extended for 10 miles into the Gulf of Thailand and prevented vessels of over 4,000 tons d.w. from entering the river. In addition the loan was to help towards the purchase of a tug, navigational aids to mark the channel, modern cargo-handling and other equipment and a small electrical power plant.

To-day the port of Bangkok can accommodate ships of up to 10,000 tons d.w. and has space at quays to berth 10 vessels simultaneously. Recently a second loan of $3,400,000 was granted for the further development of the port. This is to finance the purchase of three new dredgers and their auxiliary equipment in order to maintain a sufficient depth of water in the channel and harbour basins.

The increased facilities at the port, which have been made possible by the World Bank loans, have encouraged the growth of trade. Exports and imports have steadily risen in the past few years with a corresponding increase in revenue. Lighterage costs have been eliminated with the dredging of the channel and larger ships are now using the main port.

The St. Lawrence Seaway and Power Project

General Design of the Seaway and the Use of Hydraulic Models

(Concluded from page 199)

The present review of the design features of the St. Lawrence Seaway and Power Project is continued with the following article which is an abstract of a paper recently read before the Engineering Institute of Canada by D. McIntyre. The scope and object of the various model investigations is outlined, and brief descriptions of the models and the information obtained or sought from them are given.

The first half of the article deals with river channel models and reference to Fig. 1, published on p. 193 of last month's issue of this Journal, will assist in locating the topographical features mentioned. The article concludes with an account of hydraulic structure model investigations, of which the lock chamber and guard gate design work are of particular interest.

The Use of Hydraulic Models

By D. McINTYRE, M.E.I.C.
(Hydraulic Engineer)

In scope and intensity the hydraulic model study work, in various stages of completion, being carried out in connection with the St. Lawrence Seaway planning and design, is probably unsurpassed in the history of engineering. This huge model study programme has been made necessary not only by the number and complexity of engineering problems which must be solved in the limited time available, but also because of the multiplicity of interests affected by Seaway works.

In discussing the use of hydraulic models in the St. Lawrence Seaway planning and design it is convenient to separate them into two groups according to whether their purpose is to develop plans for river channel improvements, or to provide design information for hydraulic structures. Insofar as possible the models discussed in this paper will be limited to those connected with the development of a Seaway channel as opposed to those relating to power development. Hydraulic structures for which models have been built can be divided quite easily into those, such as locks and guard gates, typically associated with navigation channels, and those such as dams and spillways, typically associated with the power project. However, most river channel improvements affect both power and navigation so that practically all river models have yielded information useful to both power and navigation interests.

Organisations directly responsible for Seaway design are the United States St. Lawrence Development Corporation which has delegated the U.S. Army Corps of Engineers to design and construct the American portion of Seaway works, and the Canadian St. Lawrence Seaway Authority. Those responsible for power development works include the Power Authority of the State of New York and the Hydro-Electric Power Commission of Ontario.

Generally speaking, improvement of the river channel between Lake Ontario and the Barnhart Island power house is considered primarily a power requirement, although this improvement is beneficial to navigation. This is largely due to the fact that power requirements limit the maximum mean flow velocity in river channels to 2.25-ft. per second during the freeze-up period in order that an ice cover will be formed, while maximum mean velocities of 4-ft. per second may be tolerated in navigation channels. River improvement works upstream from the power house have, therefore, been allocated to the power interests with the stipulation that those works must also satisfy the needs of navigation. As a result of this arrangement, all models for this section of the river have been constructed by the Hydro-Electric Power Commission of Ontario. These models will be dealt with first, beginning with those representing upstream reaches of the channel.

All river models are of the fixed bed type built of concrete, the method of construction varying somewhat at different laboratories. With one exception these models are built to a distorted scale, distortion ratios of 1 : 1.6, 1 : 3 and 1 : 5 being used.

1. The Galop Rapids Reach.

In the Galop Rapids reach of the St. Lawrence River is located the control section for outflows from Lake Ontario. The plan for improvement of this reach calls for increasing the channel cross section, thus transferring the control of river discharges to a dam now under construction at Iroquois. The model used to develop a final plan for improvement of the Galop Rapids reach was built by Ontario-Hydro at the Islington Laboratory. The entire reach from Prescott to Iroquois was reproduced in this model, as shown in Fig. 8, the scale ratios being 1 to 100 and 1 to 500 in the vertical and horizontal directions respectively.

The purposes for which a model of this reach was required were:—

(a) To develop the most economic channel improvement plan in the way of excavation and spoil bank locations to best serve the interest of power and navigation.

(b) To find the best location and alignment for the new Iroquois lock and approach channels.

(c) To help work out a constructive programme to prevent serious alterations in river discharge characteristics during the construction period.

(d) To determine the effect of proposed improvement features on water levels and flows.

Of these, only the first two are directly related to Seaway design and will be elaborated upon more fully.

The problems of determining the most economical location for upstream channel excavation and of best alignment for Iroquois lock are related to the extent that it is desirable to maintain a straight navigation channel wherever possible. Where a straight alignment is not practicable a wider channel must be provided, and the minimum radius of curvature has been set at 5,000-ft. For the Galop Rapids reach, where considerable channel excavation is required in the interest of power development, an extensive model study programme has been carried out to develop an improvement plan which satisfies both power and navigation interests.

A proposed plan for works to be constructed by the Canadian Seaway Authority, including Iroquois lock and the approach channel upstream as far as Toussaint Island was supplied to Ontario-Hydro by the Seaway Authority. This plan was reproduced in the Galop Rapids model together with the plan proposed by power interests for improvement of the entire reach upstream as far as Prescott. In working out details of the improvement plan for this reach, it has been necessary to provide for control of Lake Ontario levels in accordance with a generally accepted scheme of regulation. At the time of writing this paper, such a scheme, suitable for design purposes, has been agreed upon by all parties concerned and model tests are in progress to determine final adjustments required in the improvement plan for the Galop Rapids reach.

To complete the story on models for the Galop Rapids Reach relating to Seaway design, one other study will be mentioned briefly. This was made by the U.S. Army Corps of Engineers at the Waterways Experiment Station at Vicksburg, Miss., during the period 1943 to 1945 in connection with a scheme of river improvement very similar to that developed in the Islington model. Basic data compiled for the earlier model, as well as much of the test data obtained, was helpful in the more recent studies.

The St. Lawrence Seaway—continued

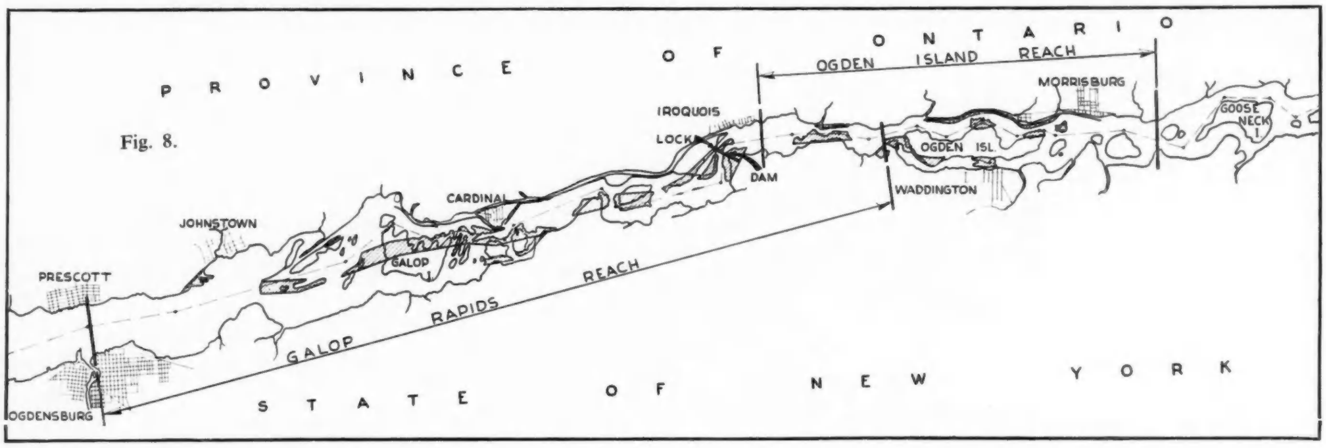


Fig. 8.

2. **Ogden Island Reach.**

The river immediately downstream from the Town of Iroquois, termed the "Ogden Island Reach," is characterised by narrow channels with velocities rather higher than the maximums specified for power and navigation. The required model was built and tested by Ontario-Hydro at their Islington laboratory, model scales being 1 to 100 and 1 to 500 in the vertical and horizontal directions respectively.

Information supplied by this model was as follows:—

(a) The most economical locations and cross sections of channel excavations required to satisfy the needs of power and navigation.

(b) The proper balance of excavations in north and south channels at Ogden Island required to maintain flow distribution as in the natural state.

(c) To delineate spoil dump areas for excavated material.

(d) To determine the effect of temporary and permanent construction works on water levels.

(e) To develop a construction programme such that the present 14-ft. navigation will not be disrupted during the construction period.

The model study for this reach has been completed with the development of an improvement plan essentially satisfactory to both power and navigation interests. This plan calls for excavations at Point Three Points; in north and south channels at Ogden Island, and the removal of the Morrisburg canal bank, as indicated roughly in Fig. 8.

3. **Long Sault Rapids Reach.**

A model of the Long Sault Rapids reach was also built by Ontario-Hydro at the Islington laboratory, and reproduces the river channel from a point upstream from Croil Island to Massena Point downstream from the Barnhart Island Power House, as shown in Fig. 9. Model scales are the same as those used in the Galop Rapids and Ogden Island models.

The main purpose of this model was to develop a programme for diversion and closure operations involved in the construction of Long Sault Dam and Barnhart Island Power House. At the time of writing this paper the diversion and closure problems had been successfully worked out, and the model was being used to study the direction and velocity of currents which will exist in the reservoir south of Croil and Long Sault Islands at the head of the navigation channel.

4. **Cornwall Island Reach.**

Three models have been used in working out an improvement plan for the Cornwall Island Reach of the St. Lawrence River. Two of these were constructed by the U.S. Army Corps of Engineers at the Waterways Experiment Station at Vicksburg, Miss., and the other at the National Research Council Laboratories in Ottawa, Ont., for the Canadian Seaway Authority.

Of the Vicksburg models, one reproduces the river from Massena Point to approximately the middle of Cornwall Island at an undistorted scale of 1 to 100. The other reproduces the entire reach from the foot of Barnhart Island to the foot of St. Regis Island, with vertical and horizontal scales of 1 to 100 and 1 to 300 respectively.

The undistorted scale model was used to work out corrective measures for high velocity cross currents in the navigation channel opposite the exit to Polly's Gut. These corrective measures will be in the form of rock dykes and a spoil bank located opposite the exit to Polly's Gut and along the shore line below Massena Point.

The distorted scale model of the entire reach was used to obtain the following information:

(a) The most economical locations and cross sections for excavaions required to provide channel depths and flow velocities required for navigation;

(b) The delineation of spoil bank areas in the river channel south of Cornwall Island;

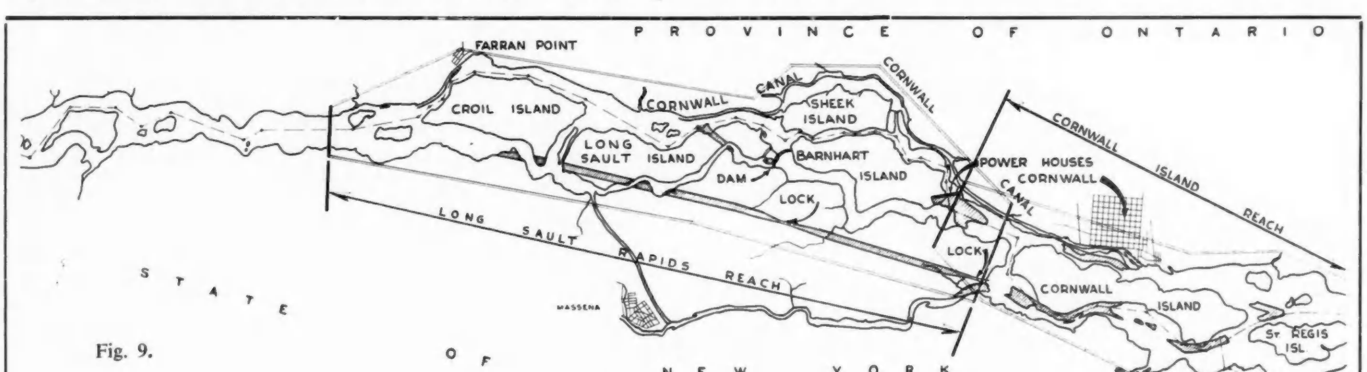


Fig. 9.

The St. Lawrence Seaway—*continued*

(c) The most economical form of compensating works required to maintain the natural state distribution of flows in north and south channels at Cornwall Island;

(d) The effect of channel improvements in the Cornwall Island Reach on water levels in the tailrace at Barnhart Island Power House.

At the time of writing this paper a satisfactory improvement plan for the South Cornwall Island channel had been developed with the aid of this model. Proposed compensating work in the form of a short length of excavated channel north of Cornwall Island was also developed in the Vicksburg model.

The Cornwall Island Reach model has been used extensively to determine the effect of various factors on water levels in the tailrace at Barnhart Island Power House. These factors include:—

(a) Various excavations in the tailrace area at Barnhart Island Power House,

(b) Various improvement plans for the downstream river channels,

(c) The regulation of water levels in Lake St. Francis at various elevations.

Data from these studies was supplied to the power interests on an exchange basis for model test data on navigation channels obtained from Ontario-Hydro models.

Information obtained from this model in the interest of navigation includes data on water depths and the direction and velocity of currents in proposed navigation channels in both the North and South channels at Cornwall Island. At the time of writing this paper, the model was being used to develop an improvement plan for the North Cornwall Island channel to be used in place of the compensating excavations worked out in the Vicksburg model. This work is being done in support of the contention of the Canadian Seaway Authority that excavations in the North Cornwall channel should take the form of an improvement for navigation in anticipation of the future development of Seaway locks on the Canadian side of the river at Cornwall.

5. Lachine Rapids and Montreal Harbour Models.

A contract has been let by the Canadian Seaway Authority to Neyrpic, Canada Limited, for the construction and testing of models of the Lachine Rapids and Montreal Harbour sections of the St. Lawrence River channel. The general location of the reach to be reproduced in each model is indicated in Fig. 10 and the scales of both models are to be 1 to 125 and 1 to 200 in the vertical and horizontal directions, respectively.

Information relative to Seaway design required from the Lachine Rapids model is as follows:—

(a) The effect of Seaway works on flows and water levels in the vicinity of Caughnawaga. If an increase in water levels as a result of Seaway construction is indicated, the model will be used to determine the extent and most economic location of compensating excavations,

(b) The directions and velocities of currents at the entrance to the Seaway channel at Caughnawaga. If undesirable current conditions are indicated, the model will be used to develop corrective measures,

(c) The effect on water levels in Lake St. Luois of older construction works, such as the bridges at Caughnawaga and the present Lachine Canal entrance pier.

The Montreal Harbour model will be used to obtain the following information:—

(a) The effect of Seaway works on flows and water levels in the Longueuil—St. Lambert area, and the most economic location for compensating excavations if these are required,

(b) Current directions and velocities at the canal entrance below Jacques Cartier Bridge. If undesirable current conditions are indicated, the model will be used to develop corrective works.

(c) The effect on water levels in Montreal Harbour of previous works dating back as far as 1870. These include excavations at various locations, the construction of Mackay Pier and other harbour works, and Jacques Cartier Bridge.

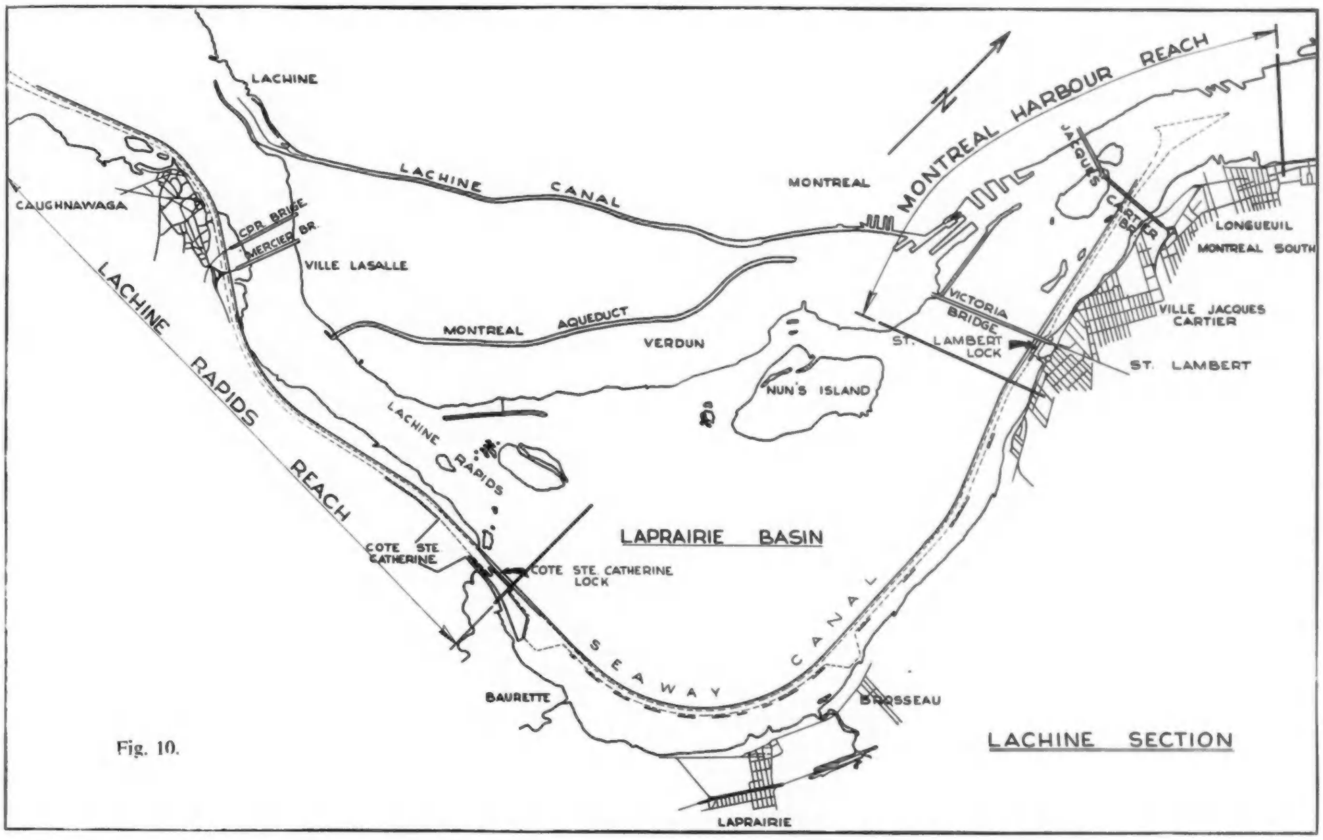


Fig. 10.

The St. Lawrence Seaway—continued

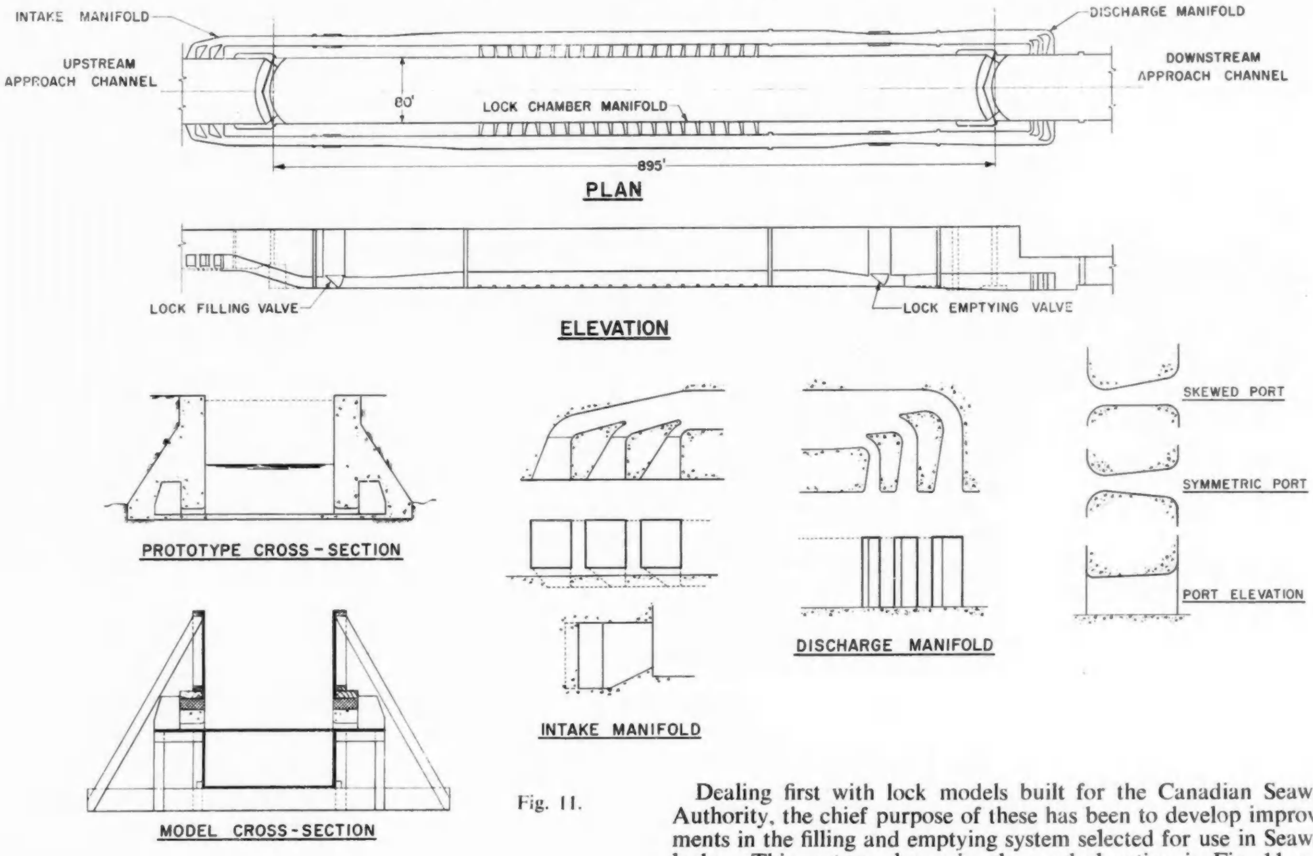


Fig. 11.

It is understood that the Lachine Rapids and Montreal Harbour models may be placed at the disposal of the Quebec Hydro-Electric Power Commission for the study of plans for power development in the Lachine section of the St. Lawrence River. They may also be placed at the disposal of municipal planning groups wishing to develop improvements such as harbour extensions, bridges and recreational facilities in the Montreal area.

In summary, it may be stated that river models are playing a large and indispensable part in planning and design for the St. Lawrence Seaway project. They have proven to be efficient tools for solving complex design and construction problems and have made a notable contribution to the development of an integrated plan of river development which is in the best interests of both power and navigation.

Hydraulic Structures Models.

Hydraulic models have been used to obtain design information on filling and emptying systems for Seaway navigation locks, and on the operating characteristics of guard gates. Models of both locks and guard gates were constructed by the U.S. Army Corps of Engineers at the St. Anthony Falls Hydraulic Laboratory at Minneapolis, Minn., and also for the Canadian St. Lawrence Seaway Authority at the National Research Council Laboratories in Ottawa, Ont. As will be more fully explained later separate models were required by the United States and Canada to develop special design features to take best advantage of foundation conditions encountered at the different lock sites. Co-operation between the Corps of Engineers and the Seaway Authority in the matter of hydraulic structures design has taken the form of an agreement on governing dimensions for locks and an exchange of ideas on lock design and model work. The U.S. Army Engineers, with their very considerable previous experience in the design and construction of navigation locks, were able to contribute important leads to lock design improvements, particularly during the early stages of model study work.

Dealing first with lock models built for the Canadian Seaway Authority, the chief purpose of these has been to develop improvements in the filling and emptying system selected for use in Seaway locks. This system, shown in plan and elevation in Fig. 11, was chosen as the simplest, most economical arrangement which could be made to perform satisfactorily in large locks with lifts ranging up to about 50-ft. as required for the Seaway project. It consists, essentially of intake manifolds, lock chamber manifolds, and discharge manifolds (see enlarged details, Fig. 11), joined by culverts through which flow is controlled by sector-type valves. Since all ports and conduits are located in the walls of the lock and approach channels, this is known as a " side-wall " system.

To fill a lock, the downstream or emptying valves are kept closed while the upstream, or filling valves are opened. Water from the upstream approach channel enters through the intake manifolds and flows into the lock through ports of the lock chamber manifold. Water leaves the lock chamber by flowing through lock chamber ports in the reverse direction to that taken during a filling operation, and is emptied into the downstream approach channel through discharge manifolds. Under maximum lift conditions, more than 3,000,000 cubic feet of water will enter or leave some Seaway locks during filling or emptying operations. The locks are designed for filling or emptying in less than eight minutes, requiring maximum flows of about 10,000 c.f.s. in the lock hydraulic systems. Improvements in lock design are concerned with the reduction of disturbances caused by these flows in the lock chamber, and in upstream and downstream channels.

Construction began on the first lock model for the Seaway Authority during the summer of 1953. At that time the United States Government had not completed plans for participation in the Seaway project, so this model represented a lock which was to be constructed on the Canadian side of the St. Lawrence River near Cornwall. The original model was modified early in 1955 to represent a lock to be located at Cote Ste. Catherine on the south shore of Laprairie Basin near Montreal. At the time of writing this paper the model was undergoing a second modification to reproduce one of the locks to be constructed at the downstream end of Beauharnois power canal. A scale of 1 to 30 has been used for these lock models.

A cross section of the Cote Ste. Catherine model, indicating some

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construction details, is shown in Fig. 11. All culverts and manifolds are removable to facilitate design changes. The chamber space below culvert level was used in the Cornwall lock model because of the great depth to rock foundation at the Cornwall site. A false bottom just below culvert level represents the floor of the Cote Ste. Catherine lock.

A pen-type recording instrument built by the National Research Council gives a continuous record of water levels in upstream and downstream approach channels and in the lock chamber as well as a record of filling and emptying valve motion. Hydrodynamic forces on a model ship in the lock chamber are transmitted to strain gauges and recorded by a chart recording oscillograph.

It was found that:—

(a) Discharge through upstream ports at the beginning of a filling operation causes water level to rise in the upstream end of the lock chamber. This sets up a surge wave which travels from end to end of the lock for the remainder of the filling operation.

(b) The shift of maximum flows to downstream ports causes water level at the downstream end of the lock chamber to remain generally higher than that at the upstream end during the latter portion of a filling operation.

A ship in the lock chamber during the filling operation is forced first toward the downstream gates, then toward the upstream end of the lock. Forces on a ship are greatest during early stages of the operation because ports are then discharging under maximum differential head, and because water in the lock chamber is shallow, and therefore subject to greatest disturbance from port discharge.

The first lock model had lock chamber manifolds of the usual design, consisting of culverts of uniform cross section running full length of the lock, and symmetric, venturi-shaped ports. A number of modifications were made in this design with the aid of models which resulted in significant improvements in lock performance. The first of these modifications was an enlargement in the culverts of lock wall manifolds as shown in Fig. 11. These were expanded from an area of 168 square feet at the filling and emptying valves to an area of 294 square feet throughout the length occupied by lock wall ports. The increased culvert area gave lower flow velocities, reducing the acceleration and deceleration effect in culverts as well as the pressure rise at ports. This resulted in a more uniform distribution of flow through lock wall ports which speeded up the lock filling operation and lowered forces on a ship in the lock. The following table of test results interpreted from lock model data indicates the improvement in lock performance brought about by enlarging the wall culverts. It also shows the very important effect of valve operating speed on lock performance.

Wall Culvert Area (Sq. ft.)	Valve Opening Time (Min.)	Lock Filling Time	Maximum Hawser Force (24,000-Ton Lake Freighter) (Tons)
168	**2.0**	**8.15**	23
294	**2.0**	**7.10**	17
294	**4.1**	**8.15**	7

A second modification, developed in the Cote Ste. Catherine lock model, was a change in lock chamber port design from a symmetrical to skewed shape as indicated in Fig. 11. A few upstream ports were skewed to direct flow toward the downstream end of the lock. This arrangement directs initial port discharge away from the upstream end of the lock chamber, thus reducing surge and the resulting initial downstream force on a ship. By installing the proper proportion of upstream and downstream directed ports, upstream and downstream forces on a ship during a filling operation were made approximately equal, and the maximum force was substantially reduced. The use of skewed port arrangement in lock chamber manifolds resulted in an improvement in lock performance comparable to that obtained with an enlarged culvert section.

Other modifications in design of the lock hydraulic system were made for the purpose of decreasing lock emptying time. The emptying time for Cote Ste. Catherine lock was reduced by as much as one and one-half minutes by increasing the throat area of lock chamber ports by nearly 40 per cent. The corresponding

Fig. 12.

reduction in lock filling time was approximately 0.6 minutes. Another reduction in emptying time of 0.3 minutes was obtained by modifying the discharge manifolds.

A somewhat modified form of side wall filling and emptying system was developed for the American locks. Although the lock chamber manifolds are very similar to those designed for Canadian locks, ports of intake and discharge manifolds are located in the floors of upstream and downstream lock approach channels. The reason for this difference in design is the greater depth to foundation rock at American lock sites which makes it possible to instal intake and discharge works below channel grade level without excessive rock excavation.

In summary it may be stated that the hydrodynamic forces affecting flow in a lock hydraulic system, and the relation between these forces and those on a ship in the lock chamber are too involved for satisfactory mathematical solution. Over the past twenty years lock model studies have brought many improvements in lock design, and studies for Seaway locks constitute another step in this process. There is little doubt that future model studies, supplemented by extensive mathematical investigations will produce further very substantial advances.

Guard Gate Models.

The purpose for which guard gates are to be used requires that they be capable of closing under any condition of flow which may exist in the Seaway channel due to failure of a downstream structure. Models were used to determine the hydrodynamic forces for which these gates and their operating machinery must be designed in order that safe closure may be made in flowing water.

The U.S. Army Corps of Engineers has designed a vertical-lift, fixed roller-type of gate, while the Canadian Seaway Authority has elected to use a sector gate design. As in the case of locks, the chief reason for this difference in American and Canadian design is the greater depth of overburden on foundation rock at the American site. A vertical lift submerging gate, therefore, provides the more economical construction in the American channel.

The U.S. Army Corps of Engineers design calls for a gate roughly 83-ft. wide by 46-ft. high to be lowered into a slot in the channel floor when not in use. A hydraulic model was built to a scale of 1 to 33—1/3 to study forces on the top and downstream side of the gate when it is raised in flowing water. For further details on this study reference is made to an article published in the "Engineering News Record," for October 27, 1955.

Guard gates designed by the Canadian St. Lawrence Seaway Authority consist of two leaves in the form of 60 degree sectors cut from a cylinder approximately 98-ft. in diameter and 41-ft. high. These gates fit into recesses in the channel walls and are moved outward into the channel when closed. The gates swing on hinges located at the apex of the sector and rest on rollers located near the circumference.

A 1 to 20 scale model was built to study operating torque due to

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hydrodynamic forces on gates of this type when they are closed in flowing water and Fig. 12 is a view of the model taken from an upstream position.

The torques required to hold a gate leaf in position with various flows in the model were measured for gate openings of up to 50 degrees, and flows ranging up to 14 c.f.s. Torques were read from a deflection guage attached to a calibrated torque arm which was used to hold a gate leaf in position.

In the original model, based on the Strait of Canso lock gate design, the skin plate was wrapped around the inner or mitring nose of the gate and extended back along radial frame members a distance of about 5-ft. It was found that water flowing between the gates tended to cling to the radial portions of the skin plates similar to the action of air flowing over the upper surface of an aeroplane wing. Resulting low pressure areas along the radial plates produced large closing torques on the gates. This torque varied with gate positions, being a maximum at a 30 to 40 degree opening.

The original design was modified, the change consisting essentially of the removal of about 2-ft. from the radial plate section. This modification reduced gate closing torque by about 40 per cent. The radial plates were then removed almost entirely, leaving sharp edges at the gate mitring noses. This reduced gate closing torques to approximately 38 per cent. of those measured for the second gate design. The remaining maximum closing torque, estimated at 550 tons feet under the worst operating conditions expected at the prototype guard gates, appeared to be partially due to circulation of water through gate frame members downstream from the skin plates.

In the model only top and bottom hinges at the apex of the sector were used, and these were made as frictionless as possible so that only torques due to hydrodynamic forces were measured. This torque fluctuated erratically in all gate positions, and the quoted torque value of 550 tons feet is the maximum indicated. Rollers used to support the prototype gates near their outer circumference are expected to dampen out the torque fluctuations. Maximum torque values measured in the model should not, therefore, be attained in the prototype.

In addition to their use as guard gates, sector gates are also to be installed in Iroquois lock in place of mitre gates as used at other locks. Since the lift at Iroquois locks will be less than 5-ft. most of the time after the pool above the Cornwall power house has been raised, this lock can be filled and emptied safely through the gates, eliminating conventional filling and emptying conduits. The model was used to obtain gate discharge coefficients for lock filling and emptying computations. These coefficients were also used to compute the rates of increase in gate discharge corresponding to different rates of gate opening. From this information it was possible to compute the height of surge together with forces produced on a ship by these surges in the lock chamber corresponding to various gate opening rates. It was then possible to recommend gate opening rates to be used in lock filling and emptying operations.

The mathematical aspects of model study work have been purposely avoided in this paper so that a broader general picture of the use of models in Seaway design and planning could be presented. This broader picture could not be entirely complete at the present time since some models are still in operation while others are merely in the planning stage. It is to be hoped that, as Seaway work progresses, other papers will be forthcoming on various details of model work and the conformity between model and prototype performance.

Great Ships and their Terminals

The Problems of Increased Draft

By J. H. de W. WALLER, D.S.O., O.B.E., M.Sc., M.I.C.E.

Until quite recently The Great Ships have been in passenger service. Now there are tankers up to 100,000 tons on the slips and passenger vessels proposed that out-grow The Queens. Sixty feet of water! Millions and millions of pounds for a dock! Where will it all end? Where is it leading to?

When we come to consider the depths of water these Leviathans demand and the areas they need to be handled safely and with expedition it becomes evident that the advantages of the natural harbour assume unprecedented importance. The costs and physical difficulties of widening and deepening existing harbours, to say nothing of maintaining them, is simply appalling and it is no use Vested Interest or The Authority trying to lay down the law; Ministers, and even Senior Civil Servants, must pipe down for we have reached the stage where Physical Geography assumes command. They will be wise who seek her help.

It is not only a matter of shelter, depth and space. These ships and their cargoes represent huge sums of money. Delays caused by fogs, traffic jams, queuing up for berths, waiting for suitable tides, and exposure to avoidable risk of collision are matters of ever increasing concern. And what about numbers? At the moment one is tempted to think of these ships as the exceptions, but is this likely to be the case? Leaving aside the question of passenger ships for the moment—so long as we live in an oil age it is only reasonable to assume that if, as expected, the Great Tankers prove economically successful we must look forward to their use on an ever increasing scale.

As the St. Lawrence project matures a new state of affairs will develop: across the Atlantic a second terminal to New York will be available for these newcomers. If Canadian oil reaches our ports as Western Europe must hope it will, there can be no doubt that the move towards monster ships will receive fresh impetus—and will not all freighters tend to follow suit?

To foretell the future is a tricky business but at least we must try. All the circumstances seem to indicate that Western and Northern Europe must have new ports to fit this new scale. Nature has not been over liberal in scattering such favours. Fortunate indeed will be the countries who can supply this need.

A Proposal

What has been written touches on some aspects of this great problem, very briefly and with obvious inadequacy. The whole case needs treatment on a scale that cannot be attempted in a single article, nor is the writer, or indeed any one writer, capable of dealing with it adequately. One can, however, make suggestions and it may be helpful to take a specific example of an actual natural harbour and see how far it can fill the bill. The writer, being an Irishman, thank God, will attempt to describe what his country can offer.

First of all take a globe, a map is quite useless, and see where the West Coast of Ireland really is: see how very close it is to North America: note that its South Western coasts are as near the Cape and Gibraltar as are those same coasts of Britain: note that it rests right in the middle of the path of the Gulf Stream.

Then look at the accompanying illustration showing the Estuary of the Shannon. It opens into the Atlantic just across the way from the St. Lawrence and at a point which has commonly been dubbed, on both sides of the ocean, " the next parish to New York." Study of this little map will reveal the following points all of which bear on the subject.

1. The Estuary from its mouth to Foynes Island provides a twenty-five mile stretch of water with a depth of 60-ft. or more at low water springtides.

2. This 60-ft. contour comes quite close inshore at several places and provides on either shore sites for straight wharfage, literally miles in length.

3. The 60-ft. channel at its narrowest (Tarbert) is 1000-ft. wide and may be increased to 1,500-ft., or even 2,000-ft. with what may be regarded in these days as negligible expense.

4. At the Eastern end of the Estuary is the small but thriving harbour of Foynes; rail and road connections already exist; Shannon Airport is only 12 miles away.

Great Ships and their Terminals—continued

Two very important points come next. The Estuary up as far as Foynes Harbour—the principal oil port on the west coast—is literally fog free. It suffers from fog less even than Shannon Airport which enjoys world-wide fame among airmen in this respect. What causes this absence of fog may be difficult to explain but perhaps it is that the warm, humid and therefore light, airs above the Gulf Stream are forced to " ride high " by the colder atmosphere over the land and so cloud level is kept comparatively high for the first few miles: be that as it may, it is only on very rare occasions that a ship using Foynes Harbour has been held up by fog or even forced to slow down.

Secondly, there is practically complete freedom from converging of transverse shipping lanes; collision risks are negligible. When one remembers how at times we read of ships being held up by fog when seeking entrance to North European ports and of the occasional collisions that occur in those congested channels and in spite of radar and the superb skill and watchfulness of our ship-masters, and when it is borne in mind that fog will slow up or halt a big ship quite as effectively as a smaller one and that risk of collision is mainly governed by the number of ships in a given area and not their size, the importance attaching to these considerations may be assessed. To delay a 10,000 tonner is bad enough; to hold up a 100,000 tonner is at least ten times worse.

An Entrepôt

Referring again to this question of space, it must be remembered that wherever these Great Ships berth there must be ample room so that they may swing and moor in safety and so that there shall be plenty of accommodation for smaller vessels whose functon will be to distribute these immense cargoes. It has been pointed out in the daily press that oil brought to one great port in Britain can be piped to the scattered refineries. This may be true and economically possible but other countries besides Britain are calling for the service of a major port. There is already an ample supply of tankers that can ferry the oil to the refineries wherever they are. That presents no problem. What we need is at least one main entrepôt where they can be loaded quickly and cheaply and this means lots of space. Whether Shannon Estuary—let us call it The Estuary—has enough space admits of no specific answer at the moment, enough to say it offers an exceptional amount of natural, deep, well sheltered water.

If, as the writer has in mind, the real need of Northern and Western Europe is of one or more great central all-nation entrepôts it is worth while noting that Eire is a neutral country, athirst for development and possessing an ample supply of high grade manpower. She is on friendly terms with all the Powers concerned.

Oil Storage

While on the question of oil one should consider what the tanker should do when she berths. The simple answer is—discharge and get out! But how? It would be a sorry business if avoidable delays should occur at this stage. So long as secondary tankers are available when wanted all is well; presumably they can be loaded quickly at various berths, or at dolphins, by pipe and pump. But it is scarcely conceivable that they can be made available just when wanted unless they, in turn, are to be kept waiting for the mother ship. They have journeys to make and their own business to attend to and cannot possibly be expected to keep accurately to schedules dependent on the movements of the main supply tankers. It must be quite evident therefore that large scale storage, if economically practicable is most desirable.

To store oil in really large quantities has never been seriously attempted. The tank farm fulfils its purpose of facilitating local distribution and feeding the local refinery but for building up anything like a reserve and keeping fuel safe from enemy attack—or tiding over irregularities in supply caused by the frolics of international politicians—simply does not enter the picture. There follows a suggestion that may lead to a solution.

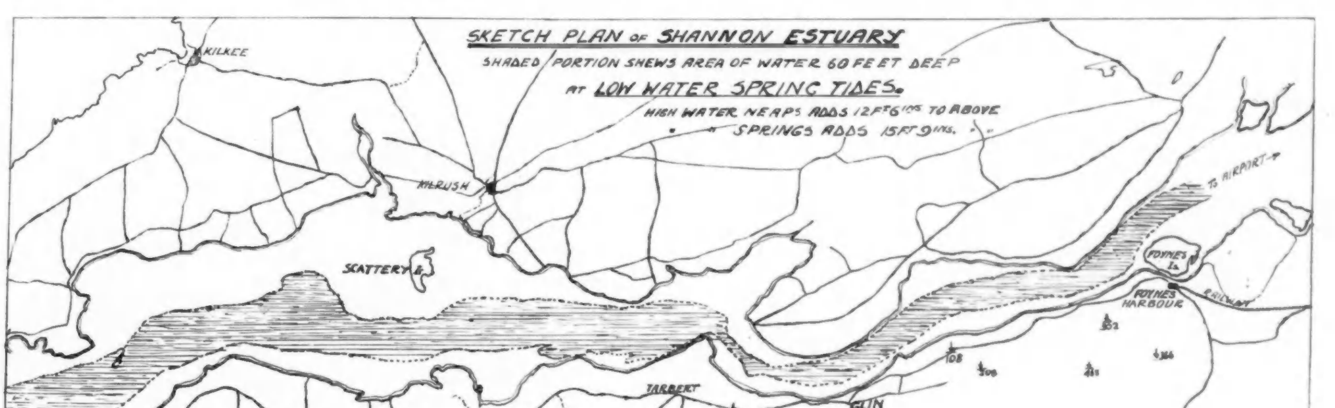
At places on the southern shore of The Estuary, and to some extent on the north side, the ground rises sharply. These little hills consist of shales and carboniferous limestone which are easily mined. It is a perfectly practical proposition to open up galleries in these formations on almost any scale required and, with modern mining techniques the cost per yard cube would be very reasonable. Now come back to the Gulf Stream, which, though not causing fogs in this area does ensure an exceptionally regular rainfall. This water, sinking into the strata, presumably keeps it constantly saturated. Will not this water gradually seep into our galleries? The galleries will be filled with oil. The oil will not mix with the water which being under a considerable head will continue to seep in. Being heavier than the oil the seepage will sink to the bottom where its level can easily be controlled. The galleries will thus be floored and lined with water.

All this may be quite impracticable for geological reasons. In the shale, for instance, there may be sulphur and it may be better to turn to the limestone. There may be faults in the limestone; these would be sealed but so long as the strata above and around the chambers can be kept saturated with water under pressure it is difficult to see how the oil can break bounds; further lining should therefore be unnecessary. One cannot resist the feeling that this proposal is worth study if only because it is a method of storage closely allied to that adopted by The Creator. He it was who made those hills. He formed The Estuary.

Passenger Traffic

Brief mention must be made of the possibility of monster passenger ships seeking accommodation in The Estuary.

The impetus given to trans-atlantic tourist trade in late years by the great air liners has produced remarkable results. The more people cross the Atlantic the higher rises the tide of trans-ocean tourism. This is a matter of the greatest possible importance to the whole of Europe. The introduction of holidays with pay has



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added enormously to the number of people who would like to make the crossing. It is principally the cost that checks the flow. Lower the cost and a flood of not-so-wealthy but very welcome people will pack their grips.

The way to cut the cost is to use Great Ships and to arrange matters so that they can make the largest possible number of round trips every year. Here, without doubt The Estuary with its famous Airport is in a unique position. Provided suitable terminal ports and the Great Ships that have already been described in the press are available, the great expense and, what is for many more important still, the intolerable boredom and anxiety of the transatlantic air journey can be eliminated and, this most desirable traffic effectively stimulated.

Doubtless this reference to the boredom and anxiety of trans-ocean air journeys will be questioned, but the truth is that for most people an air journey of three or four hours is an interesting experience—but the expensive noisy hours spent over the ocean have little to commend them. The Ship is the solution.

In Conclusion

Civilisation to a large extent is built on a foundation of fuel. The age of timber and charcoal have gone; the age of coal has passed its zenith; the age of oil, that source of power that has lain hidden for so long, now takes the centre of the stage.

Oil has brought with it a sudden and violent change in ocean transport. The tanker of yesterday was quite happy in 5 or 6 fathoms. It now asks for 7-8-9-10 fathoms and the cost of providing such harbourage is positively frightening. But frightening or not, this problem must be faced, must be solved, because upon a satisfactory solution depends its price and availability in this new age.

It is easy to brush the question aside and say—" leave it to the oil companies, they will pay." Admittedly the oil companies have worked marvels: they have brought this new age into being, but they do not pay. It is a fallacy to say they do. We, the people, pay and the cost affects the budget of each one of us in no uncertain manner.

The foregoing paragraphs are not intended just as a boost for The Estuary. The Estuary in the view of the writer is a promising part-solution of our problem. The real point of this article is to endeavour to get the problem in true perspective and to induce Ship Owners and Engineers to stand back and take a really comprehensive view—not to tinker with existing harbours if the cost is excessive unless all other solutions have been found wanting.

It is much the same with passenger business. This traffic affects the people of Europe and America in a most intimate manner. To visit each other, to get to know each other's countries and points of view and ways of life and so clear up existing misunderstandings and avoid their repetition, are objects worthy of our most serious concern. Can The Estuary help?

The Dock Labour Problem

A Suggested Solution to Reduce Casual Working

In his presidential address to the Institute of Transport, on 8th October last, Mr. Francis H. Cave, general manager and secretary of the Mersey Docks and Harbour Board, gave as his subject " The State of the Ports." He put forward some controversial suggestions for improving the present unsatisfactory employer-employee relationship in the port working industry, and contended that a solution to this problem was essential to overcome the casual labour mentality.

The following extracts are taken verbatim from his address. After a brief introducton, Mr. Cave said that no part of the transport system of this country has received more public criticism since the war. Government Inquiries, Committees and Working Parties have abounded; the shipping industry has complained bitterly about the slow turn-round of their ships in port; road transport undertakings have been annoyed by delays to their vehicles at the docks; traders have joined in the chorus on the ground of slow and careless handling of their goods; and last, but perhaps most important of all, labour has shown its discontent and restlessness by means of an unparalleled series of strikes.

Material State of the Ports

I think it is axiomatic that no port with a long history of service to the Nation can have an absolutely efficient lay-out. The development of ships, cargoes and handling methods during the past hundred years has been too rapid. To this extent Continental ports which were wiped out during the war are now in a very enviable position. Several of our ports received heavy damage during the war but none was so obliterated that it was necessary to redesign it from scratch. We were, however, amazingly fortunate in the foresight shown by our predecessors in developing our ports ahead of current requirements and I think it is true to say that at the beginning of the war our ports though by no means physically perfect were as good as any in the world.

Nobody knows better than I the frustrations which we all experienced in reconstructing our ports. We suffered with the rest of industry through shortages of material of all kinds. In addition, the rush of post-war trade, especially exports which occupy port accommodation half as long again as imports, necessitated a spread over in our reconstruction and we are still carrying on for the time being with a certain amount of damaged accommodation. In spite of this we have gone ahead. The most striking change has been in the provision of mechanical equipment. Many millions of pounds have been spent on floating, discharging and mobile cranes; on mechanical trucks and tractors; on fork-lift trucks and a host of minor appliances.

All in all, I think the ports have done a good job in regard to physical reconstruction and improvement since the war. They are already in pretty good shape and much more is in hand. With the exception of certain entirely new ports on the Continent and certain restricting factors in the increase of mobile quay equipment I have never in my travels seen any ports which, on balance, can beat them.

Dock Labour

This is one of the most difficult and controversial subjects with which it has ever been my misfortune to be concerned. It is the weakest link in the chain of port operations and a great deal of clear unbiassed thinking and consequent action is necessary if there are to be the opportunities for happy and prosperous employment which those working in so great and essential an industry have the right to expect.

To obtain any clear idea of present problems it is necessary briefly to look back into the past. The wasteful use of dock labour during the war was intolerable. Mr. Ernest Bevin, the Dockers' K.C., was Minister of Labour and he drew up schemes which in effect provided for the registration of both dockers and employers at each port; it also provided an obligation on the dockers to present themselves for work at recognised times; and, subject to this, a guaranteed payment, financed by a levy from all employers, for each turn for which there was no work available. It is of interest to note that the obligation to report regularly for work met with a considerable amount of opposition from many dockers who apparently liked the freedom of casual employment in spite of the irregularity of their earnings.

At the beginning of 1946 it was clear that the industry could never go back to the pre-war unorganised casual system and in that year Parliament passed the Dock Workers (Regulation of Employment) Act which made provision for a Scheme to ensure greater regularity of employment for dock workers and to secure that an adequate number of dock workers is available for the efficient performance of their work. The Scheme was to be made by the Minister of Labour either as the result of agreement between employers and workpeople or failing such agreement the Scheme was to be prepared by the Minister himself. In fact, agreement could not be reached and after two enquiries held by Sir John Forster and Mr. John Cameron (as he then was) the Minister published a Scheme in June, 1947. In its main items this Scheme follows the war-time systems and it is the statutory instrument which

The Dock Labour Problem—continued

controls the present set-up of the dock industry. It provided for this control in great detail but the most important points are as follows:

1. The Scheme is administered by a National Dock Labour Board consisting of an independent Chairman and Vice-Chairman appointed by the Minister and eight members, four each from the employers' and workpeople's sides of the industry.

2. The National Board delegates as many as possible of its functions to Local Boards in each port or group of ports. Local Boards consist of equal numbers of employers and workpeople without independent Chairmen or Vice-Chairmen.

3. The Board either directly or (mainly) through the Local Boards—

(a) Registers the necessary number of dock workers in any port.
(b) Registers the approved employers in any port.
(c) Allocates dock workers to employers as required, either on a weekly or casual basis.
(d) Pays the earnings due to the workpeople from the employers and supplements those earnings by an agreed payment if no work is available. This supplement is paid out of a percentage levy made by the Board from employers based on the men's earnings.
(e) Exercises disciplinary functions in respect of workers reported to them by the employer for unsatisfactory conduct.
(f) Provides welfare and training facilities for the workpeople, the cost being included in the levy referred to in (d) above.

It is to be noted that although the Board provides the workers to the employers and exercises all disciplinary functions in the industry it is not concerned with either rates of pay or working conditions. These remain the responsibility of the National Joint Council and Local Joint Committees for the industry.

The docks industry has never had an enviable reputation for peacefulness and in days gone by it was not to be wondered at. But since 1947 it has been governed by a system, the basis of which was tried out for five years during the war; which was enquired into by two leading industrial lawyers before being put into effect; which gives the workpeople's representatives equal representation with the employers on the administering boards; and which, in addition, has the authority of Parliament behind it—and still the industry is bedevilled with trouble and disputes. During the lifetime of the Scheme the man-days lost through disputes on the docks have been 3½ times as great as those in shipbuilding; four times as great as those in coalmining; and nearly 20 times as great as those in engineering. There have been six major strikes and about thirty smaller ones, other than minor disputes. No wonder that the Government have found it necessary to institute four Inquiries during these eight years, the first three of which dealt with specific disputes and the last (the Devlin Inquiry) dealt with the whole operation of the Dock Workers' Scheme.

Amongst the Inquiries which have taken place two are especially worthy of study—those which are generally known as the Leggett and the Devlin Inquiries. The former, of which Sir Frederick Leggett was Chairman, was set up to inquire into unofficial stoppages at the London docks. Sir Frederick, with his unrivalled knowledge of industrial disputes, took a very broad view of the terms of reference and produced a fascinating report which ranged over the whole background of the unrest in the industry, the activities of unofficial leaders amongst the work-people, the Dock Labour Scheme itself, and the relationship between the Trade Unions and their members. The Report (April, 1951) made a number of major recommendations which have not been implemented, largely owing to opposition from the workpeople's side of the industry.

The Inquiry conducted by Mr. Justice Devlin's Committee had very specific terms of reference—to inquire into the working of the 1947 Scheme and to advise what alterations, if any, should be made in its terms. The Report is a very full one which traverses again the origin and nature of the Scheme; examines at length the industrial unrest which has taken place since the Scheme came into force and concludes that this unrest cannot be attributed to any provision in the Scheme that has turned out to be unworkable; gives detailed and highly critical consideration to the employers' proposals which it rejects; and finally having expressed the opinion that with goodwill on both sides the organisation set up by the Scheme is capable of bringing peace to the industry, it confines itself to recommending only very few and very minor amendments to the Scheme.

In considering the cause of the peculiarly bad record of the dock industry it is perhaps of value to compare its conditions of work with those of industries which are more settled, peaceful and happy. I recently asked a friend of mine who is a large and successful employer of labour what he thought to be the essential requisites to ensure a happy and contented labour force. He gave me five:—

1. Regular employment on work suited to a man's capacity.
2. The opportunity to earn a good wage.
3. Working regularly in the same group, i.e. with the same men under the same foreman.
4. Careful selection and training of foremen.
5. Good working and welfare conditions.

This will seem obvious common sense to most of you but the regrettable fact is that all these requisites are not normally present in dock work. The men themselves are broadly speaking sound and capable: they have the opportunity of earning good wages; regular foremen are carefully selected, but casual foremen are still employed who may to-day be foremen and to-morrow ordinary members of a gang; welfare conditions are improving rapidly but working conditions are inevitably variable though they could be improved.

It is regular work in the same group for the same employer which is lamentably rare. The fact is clearly stated in both the Leggett and Devlin reports.

I think it is clear that there can be no ordinary employer-employee relationship in the dock industry as at present organised and this at a time when, more than ever, stress is being laid on the value of this connection. It is, indeed, only through this normal contact that a workman can feel that he has a real interest in the industry, that he belongs there and that he can be proud of its results. To treat him as a physical piece of mechanism that is farmed out by a general employer to an operational employer is surely to overlook the fact that he is something far greater than a mere number on a list. He is a human being with all a human being's frailties and virtues.

Lest it should be thought that I am riding a hobby horse and over-emphasising the necessity for a human rather than a legal or contractual relationship in the dock industry let me quote from the two reports:—

> Leggett, paras. 39, 40 and 41. "We regard the creation of a normal and regular employer-worker relationship over the widest possible area of dock work as the most effective step that can be taken towards a more stable and peaceful atmosphere in the industry. . . . We are are aware that there are practical difficulties involved, but nevertheless we suggest that permanent employment should be extended as far as possible, and that means to minimise the difficulties should be found, including possibly the grouping of employers for this particular purpose.
>
> In order that there should be a more contented body of workers, better employer-worker relations, and more efficient organisation of the work, we think also that it is important that the members of a particular gang should be kept together as much as possible, so that the gang becomes an established unit consisting of men accustomed to working together."
>
> Devlin, para 29 (8). "Conditions in the industry have never permitted the creation of an ordinary human relationship between employer and employed which perhaps more than anything else makes for peace in industry."

These are very weighty words. Let me summarise them each in his own phrase. Leggett regards the creation of this relationship as the most effective step that can be taken towards a more stable and peaceful atmosphere in the industry; Devlin says that more than anything else it makes for peace in industry. These are not just the opinions of two eminent individuals; they are the expressions of opinion of two high powered Committees containing leading Industrialists, Trade Unionists, Economists and specialists in Industrial Welfare.

A Suggested Solution

I have stated a case and supported it with the evidence of those much wiser than I. It is that the port industry will not be contented and peaceful — and therefore efficient — until a normal employer-employee relationship is established in it. To state a case,

The Dock Labour Problem—*continued*

however, is not enough; it must be shown that it is at least not impossible to give it practical effect and that to do so is economically sound for the industry—that is to say for both employers and employees.

The factor that distinguishes the dock industry from practically every other great industry is that the overall amount of work to be done, and consequently the demand for labour, varies from day to day. It is quite outside the control of any employer and it would therefore appear to be in the employer's interest that there should be a reservoir of labour on which he can draw casually as he may require. The employers had an unregulated reservoir until 1940, since when it has been subject both to limitation and regulation but the men from it still only obtain casual employment. I wonder whether, indirectly, employers have not paid too high a price for this facility. A casual system of employment can only be to the benefit of employers in times of unemployment and even this advantage, such as it is, has been reduced very considerably by the introduction of a controlled register and minimum wage. I doubt whether it can ever be to the real interest of the workpeople, nor can it be expected to attract the best type of recruit.

It is probably not generally realised even inside the industry how great an adverse influence the casual-labour mentality has on efficiency. To quote only two or three examples, it is the prime cause of suspicion concerning the introduction of mechanical appliances and of variation in manning scales. It has often been a direct incentive to restriction of output so that the job may last as long as possible. The feeling of insecurity that it breeds is the indirect reason for the ease with which stoppages may occur in dockland where a man can move from ship to ship calling " All Out " and the dockers will stop work without knowing why. I would recommend anyone interested in this subject to read the very able summary in paragraphs 19 to 25 of the Leggett Committee's Report.

A great change will have to come in the mental approach to this problem by employers, trade unions and workers alike if in place of casual employment we are to achieve regular employment. Unless there is a real will for regular employment it will not be brought about and I must say frankly that I can find little of that desire in any section of dockland at the moment. In spite of this I'm going to stick my neck out and examine a possible line of approach. I do not claim that this one will necessarily provide the best solution but only that it will not offend against the provisions of the Scheme, the retention of which is recommended by the Devlin Committee. Self-assured infallibility is even more dangerous in dockland than elsewhere but it is only by objective examination of the several available variations that the picture will begin to emerge sufficiently clearly to form the basis of final planning. Please think of what I am going to say as just one of these variations which may perhaps suggest certain basic problems and possibilities.

First of all everyone will probably agree that if there were only one employer in each port the physical problem would be comparatively easy of solution. In London and Liverpool, however, there are very numerous employers and to a greater or less extent (Manchester is an exception) this is true of most other ports. Some of the employers are in fact very small firms indeed — firms which handle perhaps one ship in every three weeks or a month. It is impossible to include such small employers separately in any arrangement for permanent employment of labour. The Leggett Committee recognised this when they reported " that means to minimise the difficulties should be found, including possibly the grouping of employers for this particular purpose."

So the first thing to be faced by employers as a condition of regular employment is that the employer-unit must be of a certain size, to which must be allied an appropriate number of employees. The actual size cannot be determined by rule of thumb as it will vary with the size and lay out of the port, the types of ship to be worked by the employer and even with the size of the workers' register; but it must be of sufficient size to engage on a weekly basis, as in other industries, sufficient men to meet the employer's normal requirements—and this does not mean minimum requirements. The larger the employer-unit the greater the flexibility and the more readily could a certain margin of workers be absorbed but I think there is a practical limit as to size. I try to keep myself posted on the relative efficiency of the work in ports throughout the country and there are definite indications that the best output can be obtained in a unit employing not more than about two thousand men.

I doubt whether, even with the best will in the world, any employer-unit, except perhaps a single employer in a large or fair-sized port, could carry a sufficient margin of regular employees to cover his maximum requirements in an abnormal rush of trade. I cannot subscribe to all the implications contained in the statistics quoted in paragraph 9 of the Devlin report but the difference in numbers of men required in times of normal and maximum port activity will need special consideration and I propose to deal with this at a later stage.

The Financial Aspect

What will be the financial effect of these suggestions on employers?

In the first place the employer will know that instead of having to pay to the Dock Labour Board the high rate of levy (at present 12 per cent.) on the total earnings of the casual labour supplied to him, he will only have to pay a smaller levy (at present 4 per cent.) on the earnings of his men who are regularly employed. He is already, by means of the levy, financing the payment of attendance money and the weekly minimum wage to the men employed casually. The decrease in the levy will not, however, cover the additional basic wages which is the least that he must pay to each man regularly in his employment. The actual additional cost to him will vary according to the number of ships and their cargoes which he handles and the margin which he feels it possible, to allow in assessing his normal labour requirement. I suggest, however, that it would be wrong to reckon indirect financial benefits on too narrow a basis. How great, for example, have been the losses to shipowners since the war for the delays to their ships due to dockside strikes, slow working and other disturbances to the routine of the industry? It must have been colossal. I would only repeat the verdict of both Committees that regular employment is the most effective way to establish a stable and peaceful atmosphere in the industry. I cannot translate that into pounds, shillings and pence but I suggest that it should be closely examined by the shipowners and other employers.

There still remains the problem of the inescapable margin of demand for labour to meet requirements considerably in excess of the normal. This is a very real difficulty and one which must clearly be solved with the least possible element of casual work. I would like to throw out for consideration that the best solution might well be combined with a real effort by the Dock Labour Board to develop the training of new entrants into the Scheme. This training is a purpose specifically mentioned both in the Act of 1946 and in the Scheme but for various reasons practically nothing has been done with regard to it. To those who know the attention which is being paid to the subject in certain Continental countries and particularly in Holland this seems a thousand pities. New entrants engaged on terms agreed under the industrial procedure might well, as part of their normal training, include with their theoretical and educational work the practical experience of a dock worker's job in abnormally busy times. The rate of wastage in the industry is high and available recruits in training could form a substantial buffer against the variations in the demand for labour.

Finally as to the reactions of the trade unions and workers to a plan for regular employment. The Devlin committee says (paragraph 47) that " the difficulty lies partly in individual opposition and partly in official opposition of the unions." The latter would not oppose it if everyone could be a weekly worker but are cautious about a partial increase.

The tradition of casual labour dies hard. It still pervades the industry and, knowing the background which gave rise to it, one should have an understanding sympathy in dealing with it in spite of the evils which it brings in its train. I am quite sure, however, that the only way to change the casual labour mentality is to cease from employing casual labour.

I fancy that the unions in expressing their views are thinking on quite a different plane from my purpose in this Address. They are thinking purely in terms of an increase in the weekly register whilst I have always before my mind the larger concept of regular employment throughout the industry. I cannot believe this is an object which they would oppose. It is an ideal which Mr. Ernest

The Dock Labour Problem—*continued*

Bevin would, I think, have regarded as final victory in the battle which he waged so vigorously on behalf of the dockers. It is an ideal that must be approached cautiously, perhaps by slow degrees, and each step forward must be taken carefully. To bring it to completion will need much careful thought, the weighing of many conflicting considerations, a lot of give and take, perhaps a little trial and error. All I ask is that the introduction of regular employment into dock work be considered objectively without bias of tradition but looking forward clearly and confidently to the future. The object is a great one—peace and prosperity in the industry with happiness and contentment for those who work in it.

Discussion on Port Labour Problems

The article by "Onlooker" in our October issue and the address by Mr. Cave on "The State of the Ports" have already evoked considerable comment and correspondence. The following extracts are taken from three of the letters received. The views expressed are not necessarily those of the Editor.

In general terms "Onlooker's" article reviews very clearly the difficulties which confront the industry. There is no doubt that the Devlin Committee's report is generally considered to be a monumental example of missed opportunity. There can be no comparison between the value of the Leggett Report, with its clear and courageous recommendations, and the suggestions put forward by the Devlin Committee.

One fact which must now be accepted in view of the Devlin Report is that no major alteration in the National Dock Labour Scheme is at present possible.

The chief criticism of "Onlooker's" article is that whilst pointing out very clearly and fairly the present difficulties, he does not attempt a clear-cut scheme for getting peace and good work in the industry within the framework of the Scheme.

To a great extent Cave's address to the Institute can be considered as complementary to "Onlooker's" article. They both start from the premise that there is something seriously wrong with the industry; they both agree that what is wrong is by no means only the fault of one side of the industry; and in various other ways—such as the multiplicity of private employers in certain ports—they are at one. Cave goes a great deal further than "Onlooker" in claiming that the essential weakness of the present set-up from an industrial point of view is the lack of a genuine employer-employee relationship which, amongst other things, prevents the normal working of men in the same gangs under the same foreman. He points out that although many difficulties must first be smoothed out, it is possible to achieve this within the present framework of the Scheme and further that the improved stability of labour would probably be of financial benefit to the industry.

The present method of working the Dock Labour Scheme as a predominantly casual system within certain overall limits can be nothing but a milestone in the organisation of this great industry, and the time has now come to think in terms of a further step forward to regular employment. The industry cannot expect to get the best type of labour unless it can offer regular employment.

Mr. Cave's idea is not new; as he says, it was suggested by the Leggett Committee and has been discussed by employers. Basically it is the same as that of the Dock Labour Scheme, by which employers are grouped with the object of providing as continuous employment to workers as possible. If the optimum unit is about 2,000 men, then many of the smaller ports would not greatly benefit by the proposed system, except that clearly it would eliminate the machinery of the Dock Labour Board, which is believed to be a barrier between the direct employers and the men. The system would, however, require administrative machinery of some kind, except with the grouping of large employers, where it might perhaps be worked by domestic arrangement.

The principal attraction of the scheme is that, in the larger ports, it would make for fewer and larger employing units. Perhaps the most feasible approach to this, however, would be by the greater amalgamation of employers as suggested in the article by "Onlooker." The scheme, as Mr. Cave admits, would not wholly eliminate the casual element, a problem which he somewhat optimistically hopes would be met by trainees. A training scheme is undoubtedly required and has already been agreed in principle by the National Joint Council but the Unions appear to be "dragging their feet" on it. Presumably, it is doubtful whether the men would take kindly to Mr. Cave's scheme, since it would involve a much greater mobility between jobs than at present.

That a greatly increased employment of weekly workers is the answer to many of the troubles is certain but it is probable that this will be attained by allowing employers—and possibly compelling them—to take on as many weekly workers as would meet their normal requirements.

Summarised, Mr. Cave's proposal is that, in order to establish a satisfactory employer-employee relationship, casual employment should be reduced to a minimum by, firstly, increasing the size of the normal employer-unit so that many more workers could be engaged on a weekly basis and, secondly, launching a training scheme for port workers and permitting the trainees to take ordinary employment at times when more than the regular workers were required. These two suggestions are worthy of very careful examination.

Two of the most important questions which arise from them are: (1) what is the attitude of the Unions to a proposal to make a big increase in the number of weekly workers? (2) would there be sufficient trainees to meet the fluctuating needs of British port work? With regard to (1), the Unions have one particular objection to the creation of a large force of weekly workers. It is that the remainder of the men will get comparatively little work. That objection would be dealt with, however, if the answer to question (2) above were "Yes," but it is doubtful whether it would be.

It is unlikely that any employer (or group of employers) would engage on a weekly basis more workers than are necessary to meet much more than his normal minimum needs. Port work fluctuates so much that, even with employer-units, this figure might not be more than 35 per cent. of maximum demands. Even if, in the interests of always having good labour at their disposal, employers were prepared to raise this figure to, say, 60 per cent., the training scheme would still at times have to supply 40 per cent. of the total labour requirements.

That figure seems too high for a training scheme which could deal with no more candidates than a number approximately equal to the normal wastage from the Pool. At the present time, this wastage is small. In the whole of Britain at the beginning of 1955, there were about 75,000 men on the main register. The outflow during that year was some 5,250 men or approximately 7 per cent.

Examining the matter again in the light of this information, even if employer-units were prepared to engage weekly workers to cover 60 per cent. of their maximum requirements and could also call on the training scheme to supply another 7 per cent. at peak periods, there would still be the remaining 33 per cent. to provide and these would have to come from the Pool. Thus, there would still seem to be a need for a considerable number of men to be retained in the Pool for directing. Many of these men, however, would often be waiting for jobs.

In most but not all instances, the directed men would be the least keen or the least efficient, because they would be the least sought-after for "permanency." From the industry's point of view it would certainly make for greater efficiency if the best men (those made weekly workers) got most work and the less efficient workers (those left in the Pool) got least. This would suit many employers and perhaps the majority of the men. It would also suit the Unions in their capacity of part managers of port labour but not (for the reason already stated) in their capacity of men's representative—a pertinent comment on the operation of the scheme.

Mr. Cave's proposals are too important to ignore. That for a training scheme should receive immediate attention, particularly in these days when new intakes should be mechanically minded. The proposal concerning employer-units has long-term implications based on the assumption that it would be better for the ports to suffer from labour shortages occasionally than to have these huge losses in working time due to unrest.

Density of Spoil in Suction Dredging

A New Type of Gravitometer developed in New Zealand

By J. A. CASHIN, M.I.C.E.
(Chief Engineer, Lyttleton Harbour Board)

SINCE the inception of suction dredging the need has been felt for a means of measuring the density of spoil being pumped. This is particularly so in the case of the "dry hopper" dredger in which the whole of the mixture pumped into the hopper must be transported and discharged. As the cost of carrying and discharging is usually very many times that of actual dredging, it is obviously of great importance to avoid carrying large quantities of sea water at the expense of bed material.

The following article outlines the position, and puts forward a solution developed in New Zealand.

Lyttelton, the principal port of the South Island of New Zealand is situated some five miles from the sea on the northern side of the sea inlet Port Lyttelton.

Port Lyttelton roughly eight miles long and one-and-a-half miles wide, faces the sea in a direction ten degrees north of east. The heaviest seas in these parts are from the south-east and these are refracted around Banks Peninsular (Fig. 1) and at times run right up the inlet.

The bed of the inlet is extremely flat, with cross-slopes rarely exceeding one in five thousand and with a regular slope seaward of about one in one thousand or one fathom per nautical mile. The inlet is well sheltered by hills which rise steeply from the water to a minimum height of a thousand feet.

The geological reasons for the flatness of the bed, although interesting and not completely understood, have no place in this short article, but the effects of this feature upon the port are of very considerable interest and importance.

In most cases a sea inlet will have a bed shallowing at the sides so that incoming waves have their flanks continuously refracted to break on the fringing beaches with consequent attenuation of the waves as they run up the inlet. In Port Lyttelton, however, the waves are almost unchecked so that after a five mile run up the inlet they may reach the harbour with a height of some 10-ft. trough to crest, a wavelength of some three or four hundred feet, and a periodicity of twelve seconds.

The material forming the bed is extremely fine, a typical analysis being as follows:—

Fine sand (0.25 to 0.05 mm.) ...	1%
Silt (0.05 to 0.005 mm.)	45%
Clay (smaller than 0.005 mm.) ...	54%

	Water Content %	S.G.	Density lbs./cu. ft.
Surface	85.4	1.51	94.4
6-in. below surface ...	70.0	1.59	99.3
1-ft. 0-in. below surface	63.0	1.53	101.8
2-ft. 0-in. below surface	55.0	1.68	104.9

The mobility of the material may be judged from the fact that in six fathoms the action of a tug's propellers brings a trail of mud to the surface.

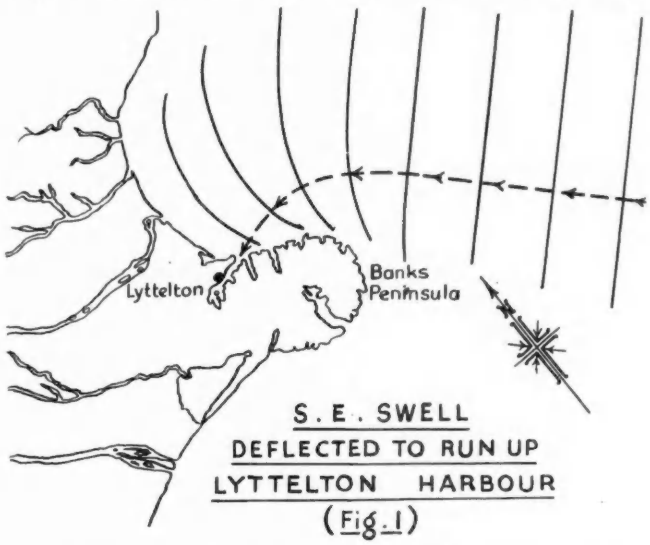
The natural depth at the entrance to the moles was originally 14-ft. but on account of the increased draught of vessels using the port, a channel 2½ miles long and 600-ft. wide with a centreline depth of 32-ft. has over a period of years been cut and since maintained by the drag suction dredger "Canterbury."

The tidal range is 6-ft. on ordinary spring tides so that the maximum tidal flow of less than one knot is quite unable to disturb the bed material.

There is little doubt that the regime of the harbour bed is due to the effect of incoming swell of long wavelength stirring up the bed to form a fluid which then flows under the action of gravity to form the plane surface of extreme accuracy. The slight tilt of one in one thousand allows a gradual flow seawards, the material being replaced by hillside washings from the 50 square mile catchment area. Thus the dredged channel tends to deteriorate rather rapidly when easterly swell is prevalent but to respond well to dredging when conditions are relatively calm.

Suction Dredger "Canterbury."

Dredger "Canterbury" has a hopper capacity of 30,000 cu. ft., and a carrying capacity of 1200 tons. It is of the "dry-hopper" type, that is, the hopper is pumped out before dredging is commenced and whatever mixture is pumped into the hopper must be carried to dump as the material is too fine to settle and allow water to overflow as in a sand-pump dredger. Originally the vessel was provided with a Freuhling type draghead fitted with water jets for working in soft material, and a rotary cutter for stationary working in harder material. The vessel was designed to fill her hopper with material of specific gravity 1.45 from the bed material of s.g. 1.68, the 1,200 tons of hopper mixture thus consisting of 900 tons of material s.g. 1.68 (payload) and 300 tons of water. In the early stages the s.g. attained was very much below this figure. Larger and more powerful pressure pumps for the draghead jets were installed but still the loads were disappointing. After a considerable period of trial and investigation it was found that the best s.g's. were obtained by using the revolving cutter as a drag, a duty for which it was never intended, and a method of working which, so far as can be ascertained is unique. The s.g's., however, continued to be much too low to load the vessel down to load-line, and to ameliorate this to some extent the hopper sides were raised to increase the capacity to 31,440 cu. ft. Thus the vessel could be fully loaded with a mixture of s.g. 1.37, consisting of 774 tons payload and 426 tons of water. Over recent years, however, the average s.g. has been 1,250, representing a payload of about 510 tons. Due to this low s.g. the hopper was full but the vessel could not be loaded down to her maximum draught.



S.E. SWELL DEFLECTED TO RUN UP LYTTELTON HARBOUR (Fig. 1)

The dredging bridge carried the following indicators:—

(a) Cutter depth,
(b) Vacuum in suction pipes.

From these and from the appearance of the spoil as it entered the hopper the operator judged the density of the mixture being pumped, diverting it overside when too thin.

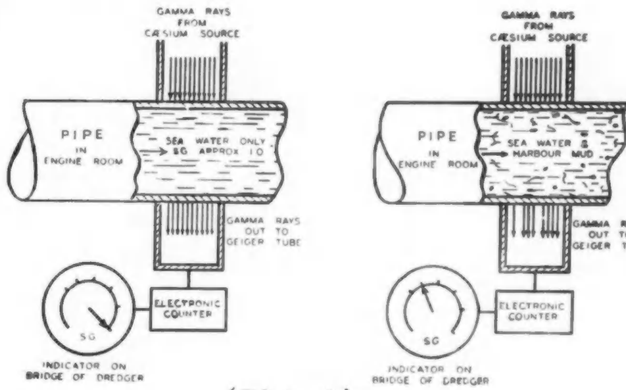
Obviously there would be a considerable advantage in his being able to read directly and continuously the density of the mixture being pumped. The problem thus posed did not appear to be

Density of Spoil in Suction Dredging—continued

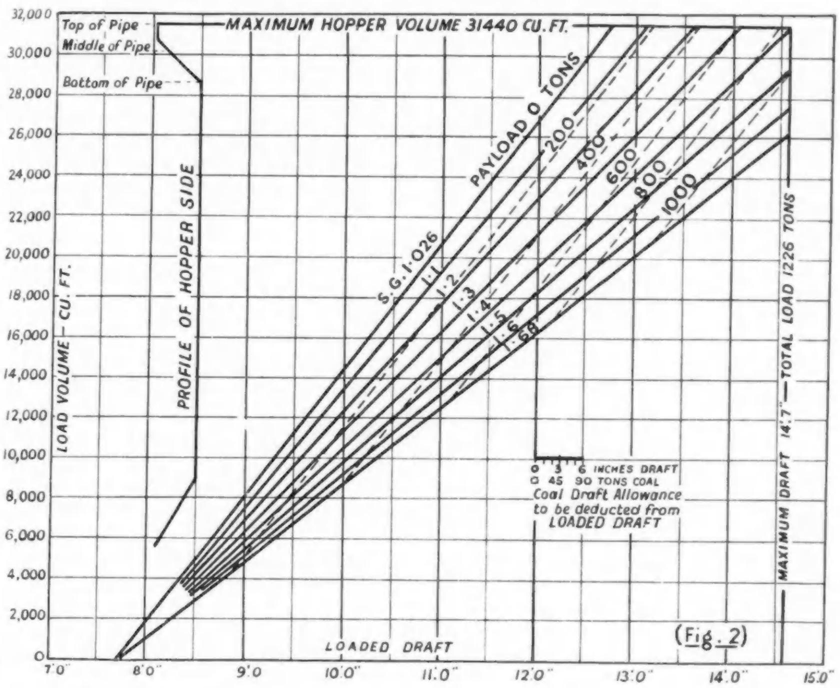
a simple one. The mixture was far from regular, at some sites consisting entirely of a thin slurry, at others carrying lumps of mud as carved out by the cutter. Correspondence with dredger builders and instrument makers revealed that no suitable instrument existed.

After studying the principles upon which instruments for various purposes worked it was seen that their application to dredging was precluded principally by the presence of lumps in the slurry. At one stage consideration was given to inserting a length of pipe flexibly mounted and carried upon some type of weighing device. Another thought was to measure pipe deflection by means of a pattern of strain gauges. Having in mind the small differences of weight which would have to be measured and the effects of rolling, pitching and vibration, the difficulties of these methods soon became apparent.

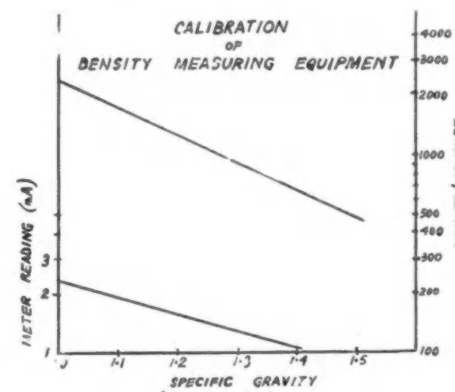
Eventually the idea of projecting an X-ray through the mixture was hit upon, possibly through a thin metal "window" at each side of the pipe, the attenuation of the energy reaching a geiger counter after passing through the mixture being a measure of the density of the material flowing through the pipe. This suggestion was put to the Director of the New Zealand Dominion X-Ray and Radium Laboratories, Mr. G. E. Roth, F.Inst.P., who at that time had recently received technical data concerning various new radio-active isotopes being made available from the Atomic Energy Authority of Great Britain. Mr. Roth suggested Caesium 137 as the most suitable source.



(Fig. 3)



(Fig. 2)



(Fig. 4)

After consultation with the Director of the New Zealand Dominion Physical Laboratory the important work of converting an idea into a reality was passed over by him to the Canterbury (New Zealand) University College Industrial Development Department under the direction of Professor T. R. Pollard and it is to him that I am indebted for the technical description of the apparatus which appears later in this article. The hazards of shock, vibration, heat and cold, condensation and so forth for a sensitive instrument in such a situation obviously call for considerable skill in design and fabrication. That no teething troubles have occurred in the first five months of operation is in itself testimony to their skill.

Professor Pollard was asked to incorporate an integrating device to average the densities over a period of about 20 seconds, so that if at a later date it was decided to incorporate an automatic arrangement for operating the hydraulic valves to divert spoil overside, hunting would not occur.

The device took some 18 months to complete and after having been tested and run continuously for some weeks in the laboratory (attached to a short length of pipe containing the mixture which was stirred from time to time) it was installed in "Canterbury" in November, 1955, on the suction pipe of the port pump. It was merely clamped to the pipe as it was found that "windows" were not necessary.

It was seen at once that a mistake had been made. The specific gravity indicated was much too low, most of the time being less than unity. The reason for this, of course, was that on the suction side of the pump gases were being released from the mixture. It was then transferred to the discharge side of the same pump where it has worked satisfactorily to date.

The ensuing five months is too short a period in which to assess qualitatively the improvement of density of the loads, having in mind the variation of the spoil in different areas and at different times in the same area. Also the vessel having been worked for over forty years with the existing instrumentation there is a certain amount of inertia to be overcome before the operator will become used to an additional meter. Operators have been in the habit over many years of trying to bring the vessel down to its maximum draught with a full hopper, and time and some patience is needed to educate them to the fact that now that they are able to obtain denser mixtures, a considerable improvement in payload is gained by achieving maximum draught with the hopper less than full. The old sailors' maxim "full and down" dies hard. The Graph (Fig. 2) shows the relationship between specific gravity, volume of mixture in hopper, total load and payload, and clearly indicates the improvement in payload with higher density and consequent lesser volume in the hopper.

With manual control of the diverting valve there would appear to be an advantage in having a shorter period of summation of

Density of Spoil in Suction Dredging—continued

densities and it is intended, as soon as convenient, to reduce the period from the present twenty seconds to about five seconds.

In order to eliminate the effect of denser material travelling along the lower part of the pipe the instrument was originally fitted so that the rays were projected vertically through the horizontal suction pipe onto a geiger tube with its axis parallel to the pipe but the discharge pipe to which it is now fitted is inclined at an angle to the horizontal. It is proposed, therefore, during the alteration to fit either three geiger tubes parallel to the centreline of the pipe, to intersect a wider band of rays, or alternatively to place the tube or tubes at right angles to the centreline for the same reason.

Technical Description of Apparatus.

The apparatus was developed, engineered and installed by the Industrial Development Department of Canterbury University College, Christchurch, New Zealand. The engineering of the electronic equipment provided a problem as the vibration of the engine room of the dredger was excessive and the temperatures covered a wide range. The electronic apparatus follows standard industrial practice, the main departure from conventional industrial circuitry being that it was operated from 230 v. D.C. without an inverter system.

The general principle of operation is shown in Fig. 3, which is self-explanatory. The instrument depends for its operation on the greater attenuation of gamma rays by a mud-sea-water mixture than by sea water alone. It consists of four main units, the gamma ray source, the measuring head, the control unit and the remote indicator.

The gamma ray source is a 10 milli Curie sample of radio-active Caesium 137. This is housed in a heavily shielded container provided with a small aperture which can be opened by withdrawing a lead plunger. The unit is strapped to one side of the 16-in. pump delivery pipe in such a manner that when the plunger is withdrawn a narrow beam of gamma rays is directed from the aperture, through one wall of the pipe, the mud-sea-water mixture, and out through the opposite wall to the measuring head.

The measuring head consists of a geiger tube and its associated amplifier and cathode follower suitably shock mounted to protect it from the severe vibration of the pump. The geiger tube is of the halogen filled self quenching type. All supply voltages come by cable from the control unit and the same cable returns the amplified pulses from the geiger tube. Although there are some 3 x 10^8 disintegrations/second in the radio-active source, it

Fig. 6. Gamma ray source and measuring head attached to 16-in. diameter discharge pipe of dredging pump.

can be shown that in this particular installation there are only 3.3 x 10^5 counts/second in the direction of the geiger tube. Further, the attenuation in the pipe is .4, in the water, .075 and in mud of specific gravity 1.5 the attenuation is .01575; the efficiency of the geiger tube is .3%. Thus, when the pipe is full of water the count rate is 32/sec. and when containing a mud mixture of specific gravity 1.5 the count rate is 7.5/sec. The measured background is approximately 2/sec. Fig. 4 gives an idea of a change in the counting rate against specific gravity of the mud-water mixture, the lower curve indicating the meter current variation with specific gravity.

The control unit draws its power from the ship's 230 v. D.C. supply. A fraction of this, 180 volts, is stabilised with gas tubes for the H.T. line and all heaters are operated in series, with dropping and surge limiting resistors from the 230 v. A small oscillator and rectifier supply the E.H.T. for the geiger tube. Apart from the above, the control unit contains two main circuits; one is a conventional pulse rate circuit which finally operates a milliammeter with a current proportional to count rate. In view of the low count rate, a fairly long (20 sec.) time constant is used. The other is a correction circuit, which, taking account of the amplitude of the pulses received from the measuring head so adjusts the total voltage across the geiger tube that it always operates close to the centre of its plateau regardless of temperature and E.H.T. variations. It is basically a pulse rate circuit which supplies a voltage output to the cathode of the geiger tube. The time constant of this circuit must be long compared with the count rate.

The remote indicator (Fig. 5) is a milliammeter calibrated in specific gravity 1—1.5 mounted on the operating bridge and connected in series with that in the control unit.

Originally it was intended to mount the measuring head as far aft as possible on the suction line, but it was found in practice that the instrument was measuring the cavitation occurring in the pipe. In the dredger "Canterbury" it is mounted on the outlet side of the pump (Fig. 6).

It has been felt that the speed of response of the instrument could be increased and this problem is being investigated from the point of view of using an increased source of gamma radiation, either 20 or 40 milli Curie sample, and the use of multiple geiger tubes in order to scan a larger cross-section of the mixture in the pipe.

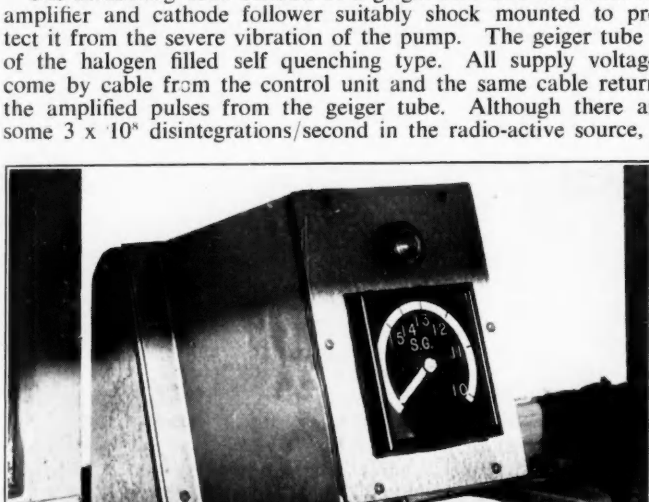


Fig. 5. The remote indicator in position on the dredging bridge.

Density of Spoil in Suction Dredging—continued

The initial electronic work was carrid out by Mr. J. Templeton, B.Sc., and carried on by Mr. R. A. Morris, B.Sc., under the direction of the head of the Industrial Development Department, Mr. T. H. Scott, B.E., A.M.I.E.E.

The uses of this type of apparatus in the fields of dredging and reclamation are obvious, and doubtless uses will be developed in other fields.

The total cost of development, assembly, testing and installation on "Canterbury" was £956, but there is little doubt that further instruments could be made and installed for less than half this amount.

A New Gravitometer for Suction Dredgers

By "ANCAIOS"

Mr. Cashin, M.I.C.E., and the Canterbury University College Industrial Development Department are to be congratulated upon the successful development of the new type of gravitometer described in the foregoing article. However the particular purpose for which this apparatus was developed, namely to endeavour to improve the overall density of the silt payload, may be considered to be somewhat specialised.

The more general problem facing the suction dredger operator, and the problem upon which the financial success or failure of his work depends, is to provide an accurate and immediate answer to the question, "What quantity of solids per hour is being pumped?" It is therefore also necessary to know at what speed the solids are passing in the discharge pipe, as well as a measure of the proportion of solids in suspension. The latter quantity, as is explained in the article, can be demonstrated as an electric current by the elegant method of using a radio-active isotope. Happily, the former quantity, the speed at which the spoil is passing through the discharge pipe, can be measured as the voltage difference proportional to the level difference in the Pitot tubes of a Venturi built into the discharge pipe. The product of the two quantities can be suitably amplified and calibrated for different types of spoil to give a direct measure of the tonnage (or volume) of the solids passing through the discharge pipe, and can also be recorded very conveniently on a domestic ampère-hour meter.

Previous payload recorders on suction dredgers have had to rely upon weighing or electrical resistance methods to give a measure of the proportion of solids in the dredgings. The comparator circuit in resistance apparatus is complicated in that the varying salinity and electrical resistance of the water in which the dredging work is being carried out, must be continuously corrected. Practical difficulties attend both the resistance and the weighing methods.

The new type of gravitometer described obviates the above difficulties, and will, no doubt, find frequent application in the future.

Warehouse Design and Construction

The Use of Precast Prestressed Concrete Units

(Specially contributed)

A method of warehouse and workshop building construction rapidly increasing in use is that employing the factory produced prestressed concrete unit. In recent years this form of construction has been greatly developed and it is one that has obvious merits in its many applications.

The principal advantages of the use of precast prestressed concrete building units lie in economy in the cost of moulds through standardisation, the high quality and excellence of workmanship obtainable with the close supervision and controlled production possible under factory conditions. Erection at the site is greatly simplified, there are no mould supports and a minimum of scaffolding is required. Moreover delivery can be so scheduled that only a limited working space is required on site, so that a smaller site staff is employed, with the result that there is an overall economy in construction costs.

Buildings constructed with prestressed concrete units require but little maintenance as nowhere are materials used which are affected by atmospheric conditions. In addition, normal decoration can be reduced as colour can be cast into the facing units to give a permanent finish, both internally and externally. Alternatively, special natural finishes such as white spar, exposed aggregate, or patterned imprints can be used.

The principal disadvantages of prestressed concrete and all precast reinforced concrete building construction as compared with *in situ* methods are: (1) the difficulty of ensuring monolithic continuity in the structure; (2) the need to cater for free-ended conditions in the units, and for stresses entailed in transportation and handling and (3) the difficulty of providing satisfactory jointing between the members of the structure.

A system of standardised prestressed concrete unit construction that has been developed to a high degree during recent years is that produced by Dow-Mac (Products) Ltd., and while possessing all the merits of this form of construction, many inherent disadvantages, it is claimed, have been eliminated or reduced. For example, by pre-arrangement in design all fixings of units are incorporated in the construction of the units and where bolts are used provision is made for sealing by pressure grouting. There is thus a minimum amount needed of *in situ* concrete and jointing mortar, and efficient homogeneous joints are obtained. Also, in design the weight of the concrete units is used in an advantageous manner to resist the deformation stresses induced by wind forces.

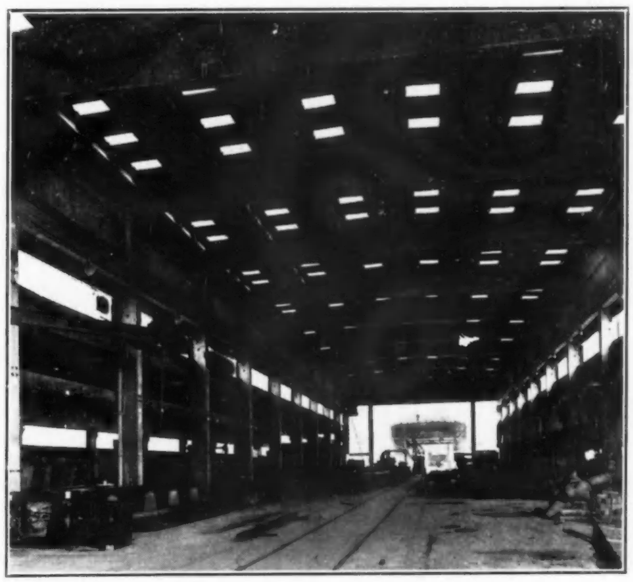


Fig. 1. Asbestos cladding and glazing completed.

The standard Dow-Mac warehouse has reinforced concrete columns varying from 15-ft. to 50-ft. long. They are erected direct from the horizontal by a mobile crane, being located in hollow base sockets up to 4-ft. deep. On lowering into their bases they are positioned and plumbed with prestressed concrete packers and steel folding wedges, after which grout followed by concrete is placed in the bases and the wedges withdrawn after the concrete has set. Where necessary, prestressed piles are used under the bases.

Main bearer beams are provided up to 80-ft. clear span. They are provided with a horizontal soffit and the decrease of depth towards the ends provides a satisfactory fall to the roof. The largest members are prestressed with 100 wires 0.200-in. diameter and in all cases the beam ends are located on the column tops by bolts and cast in nuts.

The frames, which are at centres up to 30-ft., are connected by purlins, eaves units, side members and valley gutters all in pre-

Warehouse Design and Construction—continued

Fig. 2. Alternative prestressed concrete hollow beam roof units.

stressed concrete. The columns are provided with suitable shoulders to receive these members and also to receive main bearer beams for first floors, the secondary beams in these floors being of similar section to the roof purlins. When desired, prestressed concrete crane beams up to 30-in. x 15-in. section with 100 wires can be provided to carry overhead cranes up to 10-ton capacity on a 30-ft. span.

Roofing for these structures can be of asbestos cement reinforced troughing sheets, with roof lights suitably spaced to augment lighting from standard windows, or "Perspex" glazing in the side walls (Fig. 1). Alternative roofing is provided by the Dow-Mac 14-in. wide hollow beam which is available in spans up to 50-ft. and from 4-in. to 14-in. in depth (Fig. 2). A similar version of this beam is also available as a flooring unit.

Side cladding in these warehouses is frequently constructed from prestressed concrete slabs 3-in. thick measuring 9-ft. x 2-ft. 6-in.

The basic units described above can be used to construct warehouses and heavy industrial buildings of almost any shape or size. Speed of erection is noteworthy for six men have no difficulty in erecting the framework of these buildings on previously prepared foundations at a rate of 9,000 super feet per week, to an average roof height of 30-ft. Three main erectors are followed by others grouting the structural members and further small teams of men erecting concrete wall slabs and side cladding.

A second and unique type of standard warehouse building of a smaller size is also manufactured (Fig. 3). This is supplied in lengths on a module of 7-ft. from 21-ft. upwards and at a span of 28-ft. The outstanding feature of the building is the roof, which is entirely of concrete and is erected in units 3-ft. 6-in. long, each

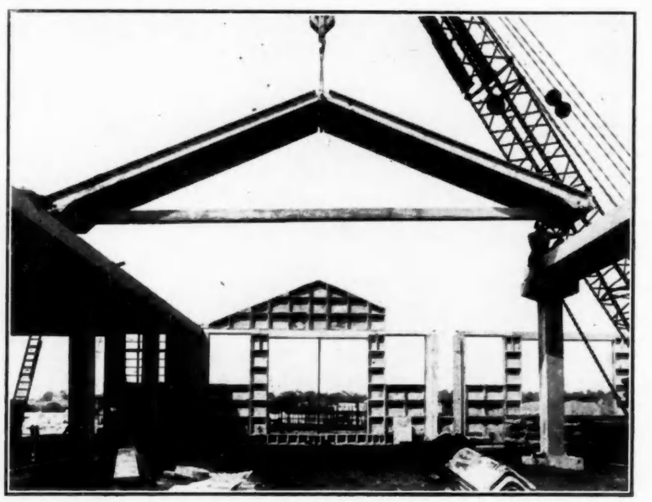


Fig. 3. Hoisting pin-jointed roof unit into position for Standard Building of smaller type.

unit consisting of two panels pitched at 22½-ft. and a prestressed concrete tie, pin jointed together to form a 3-pin arch construction. The panels are ribbed and reinforced and rebated at the edges for a patent joint which ensures weather proofing. A ridge unit with similar jointing completes the roof (Fig. 4).

The walls consist of column units 2-ft. 2⅛-in. wide at 7-ft. centres, with infilling panels 2-ft. deep, which suit standard eave heights of 8-ft. to 10-ft. and 12-ft. The walls are finished by an eaves unit suitably jointed and a similar unit follows through the gable. From this it is possible to provide a window or door in every 7-ft. panel and by the omission of a column and a deepened eaves unit it is possible to provide a door opening approximately 12-ft. wide. Gables are completed in column and panel units of shape varied to suit the roof inclination.

The system as in the standard warehouse building, naturally lends itself to multibay construction to an unlimited extent and is laid out on ridge centres of 30-ft. 10-in. The additional units are internal reinforced concrete columns, prestressed concrete valley gutters and special gable panels at the bay junctions.

These structures have the same advantages as the larger type of warehouse and should have a longer life than brickwork or in situ concrete. They have an external appearance that is pleasing and which avoids the usual typically recognizable prefabricated construction.

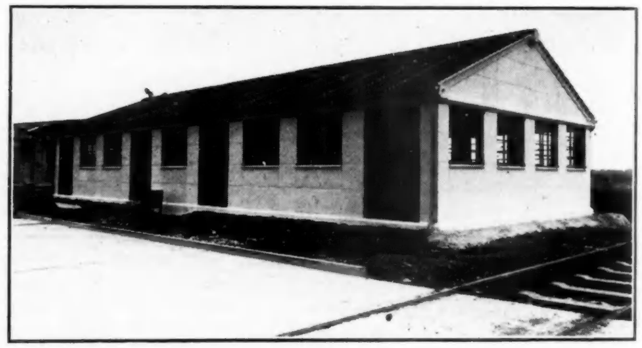


Fig. 4. Completed Standard Building showing roof ridge and barge units etc.

The same principle of rapid erection applies to these buildings where a rubber-tyred crane at 3/6 tons capacity with a 30-ft. to 45-ft. jib operating with three erectors is used. This crane offloads the units from the road vehicles in which they are delivered, erects the walls of the buildings to eaves level and assembles the three hinged roof structure, and erects. After this erection the only work which remains to be done is fitting doors, window frames and gutters, glazing, painting and sealing of roof joints with a patent strip. A team of 6 men will complete 300 super feet of finished building per day on prepared foundations.

New Equipment for British Transport Waterways.

Contracts have been placed by British Transport Waterways for three new maintenance craft for the River Trent, in the North Eastern Waterways Division; and for eight mobile cranes for use in the South Eastern Division. The contracts have been awarded to: J. W. Cook & Co. Ltd., Wivenhoe, Essex, two self-propelled crane boats. E. C. Jones & Sons, Brentford, Middlesex, one motor tug for use in dredging operations. Thos. Smith & Sons, Ltd., Rodley, Leeds, two 5-ton mobile cranes. Ransomes & Rapier, Ltd., London, one 5-ton mobile crane and three 3-ton mobile cranes. Steels Engineering Products, Ltd., Sunderland, two 4-ton mobile cranes.

A contract has also been placed with the Yorkshire Hennebique Contracting Co. Ltd., York, for the construction of the new lock to be built at Long Sandall on the Sheffield and South Yorkshire Navigation. The new lock will be double-chambered, 22-ft. wide with an overall length of 215-ft. By making possible the accommodation of craft carrying up to 250 tons—the present limit is 90 tons—this lock will remove a bottleneck between Goole and Doncaster. The total cost of the work will be over £100,000.

True Motion Radar

New Form of Presentation

By H. L. A. FOY

An entirely new type of marine radar set has recently been introduced to the shipping world. It is the Decca True Motion Radar TM46 which was demonstrated on board the Decca Company's motor yacht "Navigator" last month.

At a reception held in H.Q.S. Wellington, the headquarters of the Honourable Company of Master Mariners, the Managing Director of Decca Radar Limited, Group Captain E. Fennessy, O.B.E., told his audience that they had been invited so that they could inspect a new radar set that was revolutionary. He went on to describe the True Motion Radar installed in the "Navigator," explaining that it was unlike any other radar at sea today and included an entirely new form of marine radar presentation.

This new system of display in which all objects show their "proper" or true motion is the outstanding characteristic of True Motion Radar TM46. The components of "relative" or "apparent" movement are automatically removed so that the face of the cathode ray tube becomes in effect an electronic chart on which all ships, including own ship, are seen to move at their true courses and speed; stationary objects such as buoys, anchored vessels and land echoes remain stationary on the display and can be instantly identified.

The advantages of an unambiguous radar presentation such as this can readily be imagined. In the open sea the availability of what is virtually an automatic, instantaneous, true plot makes interpretation of the radar picture simple and sure. Information on the other ship's true course and speed, which formerly had to be calculated or very carefully estimated, is now shown directly on the face of the cathode ray tube because afterglow trails represent the true movement of echoes. The True Motion picture is selected by operating a single switch; alternatively the display can be used as a conventional P.P.I. whenever circumstances make this desirable, for example when making a landfall at long range.

In close waters a True Motion picture is very similar to that seen at a harbour radar station. The movements of all vessels in the approaches to a harbour, the identification of buoys and anchored vessels and even the progress of one's own ship, are shown with chartlike clarity. Because all movements are true, the picture can be interpreted at a glance no matter how complicated the situation.

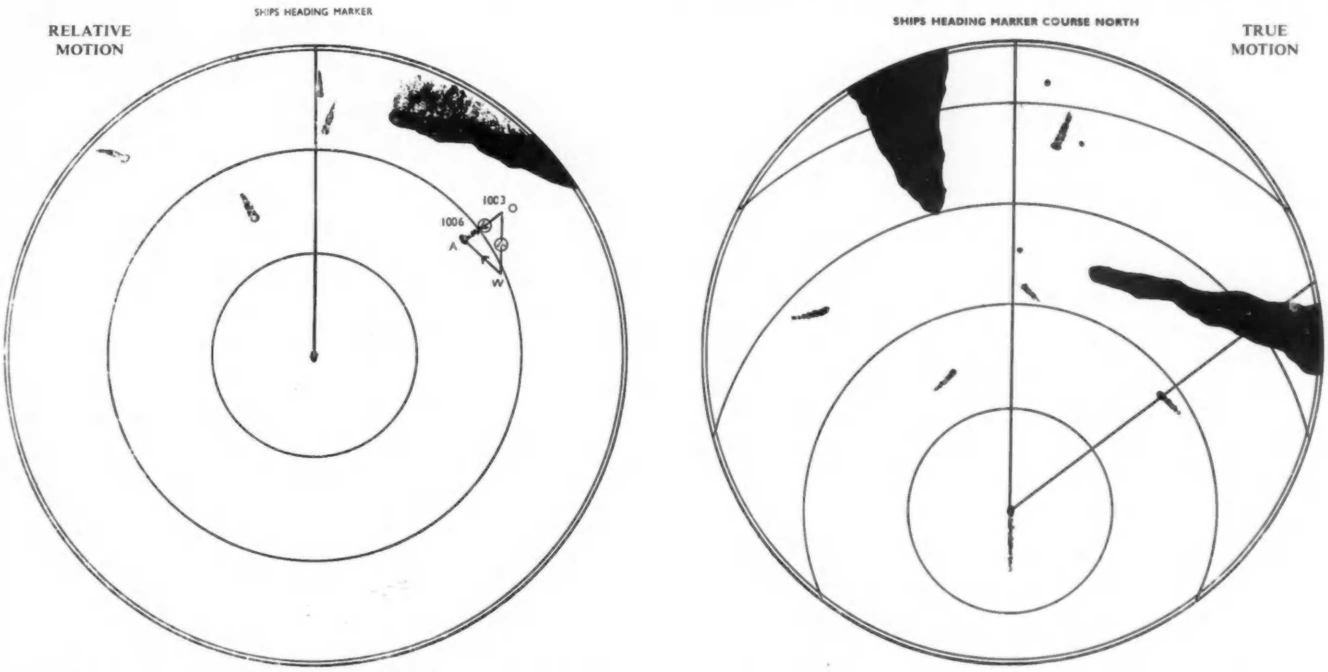
Value in Harbour Operation

From the point of view of harbour operating authorities the existence of this high quality radar picture in a ship will be of great interest. There has been a tendency over recent years for ships to make port in all weathers only to find on arrival that the limitations of radar pilotage are such that they are obliged to anchor and await an improvement in the visibility before being able to move into harbour. With the advent of True Motion Radar it is likely that this bottleneck will be overcome. Pilots will no longer be faced with a confused radar picture in the ship and be forced to rely only on information passed by R/T from shore radar stations. They will now have a picture of comparable character to that of a harbour radar set on which they can readily see the traffic situation.

At present Harbour Radar is used to give instant fixing information to ships and to assist the ship to identify targets on its own radar. This naturally involves a considerable amount of R/T conversation. When a ship is using True Motion Radar, the similarity of her picture to that of the Harbour Radar will considerably reduce the amount of information that must be passed by R/T because the ship's master and pilot can obtain unambiguous information from the ship's own radar. The combination of Harbour Radar ashore and True Motion picture in the ship will greatly assist operation of a harbour in marginal visibility conditions.

Method of Presentation

In the TM46 the display of true motion is achieved by feeding course and speed into a unit known as the Trackmaster, which is mounted on or close to the radar display. Speed and course of own ship are here converted into movements east-west and north-south. These movements control the amount of current in the off-centring coils of the display itself and affect the position of the electrical centre, that is, the position of "own ship" about which the trace rotates. When the electrical centre of a compass stabilised display moves in harmony with the course and speed of "own



These diagrams show the difference between relative motion (left) and true motion (right). When comparing the two, notice the difference in the courses of the vessels as displayed. The true motion radar reveals the true courses and there is no afterglow tail on the buoy echo ahead so that immediate identification can be made. Only accurate plotting can determine the true movement of an echo on the relative motion diagram. One example of this plotting is shown for the echo 50 degrees on the starboard bow; in practice several such plots would have to be maintained simultaneously in respect of vessels for which a collision risk may be deemed to exist.

True Motion Radar—*continued*

The Decca True Motion Radar T.M.46. Display and Trackmaster unit.

In this True Motion P.P.I. photograph "own" ship is steering about 340 degrees approaching a sharp bend in the Schelde at Bat. The buoyed channel and the traffic situation in the river can be seen clearly and immediately. A large ship on the port beam is moving up river in the channel. A small vessel on the port bow is passing outside the channel buoys and astern one large and one small ship are following.

ship," the effect on the P.P.I. is to present true motion, that is to give a "bird's eye" view of the situation, since the component of "own ship's" course and speed normally present in the apparent motion shown on a conventional display has been entirely removed.

The amount of movement imparted to the display depends on the radar scale in use and is automatically adjusted when range scale is altered.

The estimation of the course and aspect of other ships is made by observing the afterglow trails behind those ships' echoes. A mechanical bearing cursor, with parallel lines, can be used to read these courses when a high degree of accuracy is required.

Both range and bearing can be measured regardless of the position of own ship on the display. An electronic bearing cursor of very high accuracy, range rings and a variable range marker all originate from the position of own ship and can be used for measurement in the normal way.

Speed of own ship is introduced either by setting estimated speed on a calibrated dial or alternatively the output from a transmitting log may be used if preferred.

The effect of tidal stream on a True Motion picture is not apparent nor important in the open sea, since all ships are steering their courses "through the water" rather than "over the ground." When there is land on the P.P.I. and particularly in estuaries and the approaches to harbours, a tidal stream will cause the echoes from stationary objects to move very slowly in the opposite direction to the stream, since the ship's course steered and estimated speed through the water are being fed to the Trackmaster rather than course and speed made good. The movement of echoes due to the tidal stream is so slight that it does not confuse the "bird's eye" view picture whilst at the same time it leaves the navigator in no doubt of the direction and approximate amount of the set and drift being experienced. Such an indication cannot be readily extracted from a conventional display.

In certain circumstances it may be of advantage to stabilise the display picture with reference to the ground by setting course and speed made good into the resolver. In this case there will be no movement of stationary echoes and the afterglow trails behind other moving vessels will indicate their course and speed made good over the ground. The adjustment of the equipment to achieve this is best made by visual inspection of the picture. Any movement of fixed echoes in the direction of own ship's course, either towards or away, is first trimmed out by the hand-speed control. Any remaining movement at right angles to the ship's course can be trimmed out by adjusting the compass input to the resolver. When the stationary echoes are no longer moving it follows that course made good has been set on the compass dial and speed made good on the speed dial.

Method of Operation

The actual operation of the True Motion Radar at sea is comparatively simple. Once the compass input has been lined up and own ship's speed set on the speed dial the only additional controls that must be used are the "shift" controls. These control the starting position of own ship on the face of the P.P.I. and this position can be adjusted in a matter of seconds whenever it is considered that warning ahead has been reduced to the limit. Once reset the True Motion picture is developed again within about twenty seconds.

The True Motion Radar is the result of very extensive investigation into methods of using radar at sea, the problem of maintaining a plot by hand and the overriding requirement that radar information should be unambiguous so that interpretation may be sure no matter how complicated the situation. The equipment provides a visual picture on which the tails behind echoes indicate the courses of ships as readily as a ship's wake would do this to an aircraft passing overhead. Alterations of course on the part of other ships can be detected as quickly and easily as they can be from a harbour radar picture.

Extensive trials of the Decca True Motion Radar TH46 have already been carried out at sea and have proved conclusively the great advance in radar as an aid to navigation provided by this new conception of marine presentation.

Improved Harbour Facilities for Dundee.

It has recently been announced that the Dundee Harbour Trustees have agreed to the erection of a transit shed, 300-ft. by 120-ft., at the eastern end of the new Queen Elizabeth Wharf completed last year. The construction of the shed will cost approximately £30,000 and a further £12,000 is to be spent on the purchase of two mobile cranes.

Hydrographic Surveying for Civil Engineering Development

Many and Varied Uses of Modern Technique *

By Lieut.-Commander A. D. MARGRETT, R.D., R.N.R.

IT is common knowledge that hydrographic surveying originated in a crude form from the time when man first took to sea travel, and as the art of navigation advanced so did the requirements for suitable charts. Consequently to-day the Hydrographic Department of the Admiralty maintains a fleet of survey ships and produces for the use of seafarers charts of almost every navigable area in the world. This navigational use of hydrographic surveying is apparent to all, and likewise the use of such surveys by port and harbour authorities for the maintenance and conservancy of their own areas. The civil engineer has, however, many and varied uses for such surveys perhaps not as well known, and it is proposed to discuss these in general terms.

SURVEYING FOR CIVIL ENGINEERING PURPOSES

New Port Locations

Since the war, consulting civil engineers have had to select sites for new ports in various parts of the world, and in particular in undeveloped areas. In addition to many new ports made necessary by industrial development, such as Tema in connection with the Volta River Scheme, there is the rapid growth of the oil industry demanding increased tanker loading facilities as near as possible to the oilfields.

Although the choice of a suitable site for a new port does not depend entirely on the results of hydrographic surveys, it is nevertheless a fact that such a survey must prove that the area to be used is not only safe for shipping but also suitable for the economic construction of jetties, breakwaters, etc. Consequently, the civil engineer usually selects a series of possible sites or a length of coastline which will be surveyed in an exploratory manner. From this open sounding survey, a decision will be made on the area to be surveyed in greater detail. This survey will be carried out to a relatively large scale and in a different manner from a normal navigational survey. These differences in techniques will be described more fully later. The results of this large-scale survey would be used not only to ascertain the usual requirements of safe navigation but also for the design of the actual construction. Some of the numerous examples of new ports whose location has been assisted by hydrographic surveys are Tema (Gold Coast), Sidon (Lebanon), Tartus and Banias (Syria), Mena Abdullah and Mina Sud (Kuwait).

As well as being invaluable in the location and design of new ports, hydrographic surveys are also used for planning the enlargement and modernisation of existing ports. Benghazi has recently been surveyed so that the authorities may redesign the port, which was badly damaged during the war. This damage was caused by the main breakwater being torpedoed and thus leaving the harbour without any defences from the sea.

Submarine Pipeline and Cable Laying

Due to the distance of deep navigable water from the shore, or for other reasons, it may prove to be more economical to load tankers by submarine pipelines as opposed to building jetties. These submarine pipelines may also be used for unloading tankers to tank farms serving airfields, etc. Although a general hydrographic survey would show whether the proposed mooring berth for the tankers was safe from a navigational aspect, a large-scale detailed hydrographic survey would also be required for planning the laying of the pipeline. For this purpose the civil engineer would require the following information:

(a) the type of ground on which the pipeline would rest, i.e., is the foundation suitable?

(b) the exact cross-sectional configuration of the sea bed along the intended line of laying.

As the pipeline is assembled on the shore and launched by being towed out along the bottom, it follows that the cross-sections must show a steady drop without any sudden shoaling. An example of an oil terminal port where submarine pipelines have been laid following the running of special cross-sectional transits is at Sidon, where at least four tanker loading berths are now in operation.

Cable laying, whether power or telegraph cables, requires somewhat similar surveys, and although the material used is more pliable and not subject to fracture strains, nevertheless it is extremely vulnerable to chafing. Consequently the chief engineer, in deciding submarine cable routes other than in the deep oceans, must have the proposed route accurately sounded so that a track can be chosen free from such natural hazards as irregular rock formations which would damage the cable.

Model Construction

Unless it consists of rock, the sea bed is not stable and can, and does, alter. It is, therefore possible for a newly-built jetty to deflect the currents and thus cause silting at other jetties, or perhaps even change the navigational channel. For these reasons, therefore, it is usual nowadays, when planning new projects, first of all to construct a tidal model where all schemes can be tried out and proved workable before being erected on site. Tidal models of areas like the Wash, where the channels are constantly changing, will indicate the future contours, months and even years ahead. Naturally the basis of such models is sounding and current observation surveys. Further surveys are carried out periodically and the model run for a period of time equivalent in scale to that between the actual surveys. Should the model produce results comparable to the surveys, it can then equally well give results some time ahead since it is possible to put a year's tides through the model in the space of one week. The civil engineer is thus in a favourable position to plan any constructional work for a predicted suitable time ahead and he also knows that his designs will not have any adverse repercussions elsewhere.

Dredging

Surveys for dredging purposes, although normally used by port and harbour authorities, are nevertheless a requirement for the civil engineer. Normal periodic surveys will indicate the need for dredging, but only special, large-scale, cross-sectional sounding surveys will enable the engineer to compute the quantities to be dredged, and thus form the basis of a dredging specification. Port-dredging surveys would also check whether the dredger had done its work properly.

Wreck Location

The location of wrecks can also be a part of hydrographic surveying. Although the normal location of wrecks by sweeping or detailed echo search is well known, these methods are ineffective when a wreck is buried under an overburden of sand. In such cases, when it is necessary to fix the position of a valuable wreck whose position is approximately known, a large-scale detailed sounding survey of the area might disclose a small irregular mound on the sea bed, perhaps in the order of only one foot, which would indicate the wreck lying underneath.

The civil engineering uses of hydrographic surveying already mentioned do bear some relation to the sea and shipping, but some

*Paper (slightly abridged) read at the Royal Institution of Chartered Surveyors on 15th March 1956. Reproduced by kind permission.

Hydrographic Surveying for Civil Engineering Development—continued

Tidal gauge reader on station.

examples will now be given of other cases not so connected that have called for surveys in one form or another.

Coal Mining under the Sea

Although under-sea coal has been extracted in Great Britain for over 150 years in comparatively shallow water, it was not until hydrographic surveys were carried out after the war that it was decided that deep sea areas were workable. Obviously these surveys could not assist with the actual location of the coal, but they did permit the mining engineer to calculate the top permissible working level of the seam in order to maintain a safe amount of overburden between the seams and the sea bed. Areas where such surveys have been carried out are off the coast of Northumberland and in Ayr Bay.

Power Station Sites

The engineer confronted with the problem of locating a suitable site for a new power station (particularly one of the atomic variety) has not only to contend with normal siting difficulties but must also consider the results of hydrographic surveys to see if the water requirements are adequate. Such a power station will require vast quantities of water for cooling purposes and consequently, particularly on small rivers, an accurate sounding survey is necessary, together with a detailed analysis of current direction and velocities. It is then possible to calculate whether sufficient quantities of water (at the intake rate required) would be available at all states of the tide.

The analysis of the currents is likewise in order to ensure that the warm output water, on re-entering the river, does not circulate back into the intake pipe thus disturbing the thermal efficiency of the cooling system. The current analysis is further required in order to calculate to what extent the temperature of the river would be raised locally, and how far this heated water would proceed up-river on the flood tide before retreating seawards to be dispersed in the coastal drift. This requirement must obviously be known,

Surveyor plotting fix to maintain vessel on correct track.

since such a mass of warm water could have adverse effects on fisheries and oyster grounds, as well as affect some other industrial cooling plant. Such adverse effects might, of course, be the subject of a claim for heavy damages.

Another very important consideration to which the surveyor can provide the essential data is the movement of silt.

Bridge Construction

In the design of large suspension bridges, it is sometimes necessary to erect the main buttresses in the river or sea. In such cases, the foundation work will be carried out in a large bell caisson under pressure. This caisson will have to be sunk into position, and it is obvious that in order to avoid compressed air leakages the edges should be cut to conform as near as possible to the sea bed contours. It will thus be apparent that an extremely large-scale sounding survey over a limited area will have to be undertaken in order to obtain the information for the design of the caisson. Current analysis is also a requirement, since a buttress or tower constructed in the river would affect the currents and might thus cause silting around a jetty or water intake pipe position. The likelihood of this happening is now usually investigated on a tidal model.

Surveyors taking simultaneous sextant angles.

Such a model has recently been built to observe the results of a new bridge design projected for the north of England.

Oil under the Sea

Man's demand for oil has caused him continually to seek new sources of supply, and consequently in many parts of the world survey parties are seeking oil under the sea. A sounding survey, although not indicating the presence of oil, can assist the geophysicist by revealing the configuration of the sea bed. A survey is necessary also as a basis for the design and erection of the boring and subsequent production rigs.

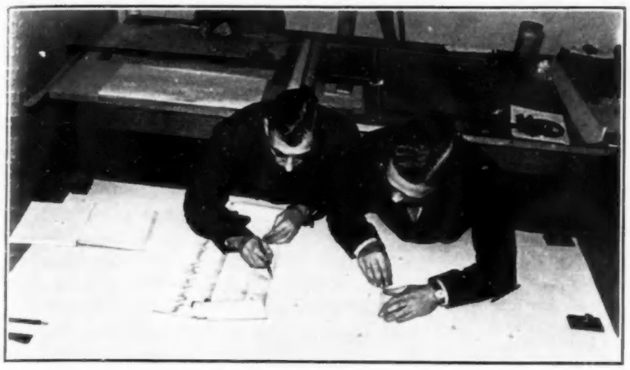
These, then, are some of the applications of hydrographic surveying for the civil engineer, but there are many more in the fields of coastal erosion, flood protection and other such schemes.

METHODS OF SURVEY

The following is a brief description of the basic methods of conducting hydrographic surveys, and at the same time an indication of the differences in technique between the requirements of navigation and civil engineering.

Naturally, before any type of survey afloat can be carried out, it is necessary for an adequate shore control to be established in order that the position of the survey vessel can be fixed rapidly and accurately by simultaneous sextant angles observed to stations of such a shore control. This land survey necessitating co-ordinated control stations and also the topographical details of the coastline, can be carried out by a triangulation, closed theodolite traverse or other method, all of which are identical with land surveying practices. Normally, however, since position fixes are plotted by mechanical means such as station pointers and not by computation, it is a waste of time to attempt too great a standard of accuracy so

Hydrographic Surveying for Civil Engineering Development—continued



Plotting Results.

long as the accuracy achieved is such that it will show no plottable error to the scale used. This is important, as most fixes by simultaneous sextant angles are resections and not intersections. Greater accuracy will, of course, be required if there is a likelihood of a triangulation having to be extended at some future date. It thus follows that since civil engineering surveys are usually to a much larger scale than those for navigational purposes, a greater accuracy in the land control is required than is normal for navigational work. This applies particularly when it is proposed to utilise the same shore control framework as a basis for construction, and in these cases precision is necessary.

Once the shore control framework is established, it is necessary to erect tide gauges and level them into a suitable datum so that tidal readings can be observed during operations afloat, and subsequently used to reduce all soundings to a common datum. In navigational surveys, soundings are reduced to chart datum — a level internationally described as "that to which the tide seldom falls"; but in spite of this loose terminology it is nevertheless an accurately defined level depending upon the tidal characteristics and computed from a long series of observations. This datum therefore is relative to the local tidal cycle and, although convenient for navigation, it is not so useful to a civil engineer who normally replaces it by the ordnance datum or the civil land levelling system in order to maintain continuity between the land levels and soundings.

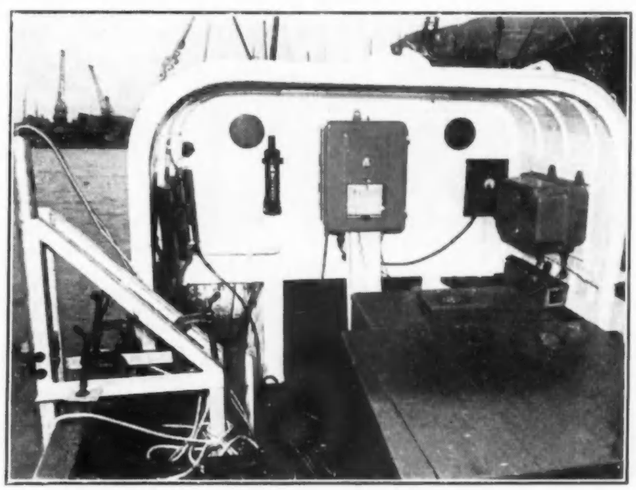
With these basic requirements established it is then possible to commence sounding operations afloat. Again different methods have to be adopted for different types of sounding. In the usual navigational type of survey with working scales of 1/10,000 or smaller, the surveyor fixes his position by simultaneous sextant angles and by plotting the fixes as and when obtained, he can con the boat down the desired lines of sounding by alterations to compass courses. These fixes are usually so spaced that five soundings are required between them, and thus soundings are read off from the echo sounder at short time intervals and reduced to datum before being inked in on the sounding chart.

Civil engineering surveys, on the other hand, are usually to much larger scales—1/2,500 being the most common. When working to such relatively large scales, it is not possible for the surveyor to plot his fixes afloat and con the vessel by compass, due to the fact that, however fast he worked, he would have steamed too great a distance between fixes for accuracy, unless he reduced speed to an uneconomic and unworkable extent. This fact can be appreciated when it is understood that an even course and speed must be assumed between fixes, and consequently too great an interval will introduce plottable errors. So on large-scale surveys, the surveyor sets out transits or leading marks on the shore by means of a traverse. These are used as a guide to the coxswain who only needs to keep the two targets in line for the vessel to run down the desired track. This enables the surveyor to check his course and fix more rapidly than when having to plot each fix as soon as it is taken. In such cases fixes will be plotted on shore at the end of a day's work. Again due to the scale used, and the consequent number of soundings required, it is impossible to read these from the echo record at a sufficient rate when surveying. In such cases fixes, as observed, are marked on the echo record, and subsequently, soundings as required are interpreted and scaled off from the echo records, interpolating between the fix marks. One advantage of scaling from the records on completion of a day's work is that the datum line can first be drawn on, and soundings, already reduced to datum, can be scaled off for direct inking in on the sounding chart.

Civil engineers usually require soundings to an accuracy of 3 inches, whereas navigational requirements are usually to the nearest foot. This fact again necessitates scaling the soundings off the echo records under drawing office conditions, as opposed to reading the soundings from the echo recorder at the time of sounding. This 3-inch accuracy might seem difficult to attain, but can be achieved under normal suitable working conditions. An error of 3 inches over a wide area would make a very great difference when computing dredging quantities.

Even larger plotting scales are used when sounding in the vicinity of jetties, these being in the neighbourhood of 20 feet to 1 inch. In such cases an entirely new system of fixing is necessary, as it is obvious that even to observe one angle and log it would take all the time necessary for the vessel to pass completely through the area being sounded. For jetties the surveyor utilises a sounding sub-tense board for fixing, which is, in effect, similar to a surveyor's 10-ft. sub-tense pole turned inside out so that the board is painted in graduations corresponding to various subtended lengths. This board is hung over the jetty, and as the vessel approaches slowly inwards on a sounding line, the surveyor holds his sextant pre-set to a fixed angle and marks the fixes on the echo record as he passes each prescribed distance off.

Another requirement common to both types of surveying is sweeping a given area for obstructions. However close lines of soundings are run, the echo sounder would still not give complete coverage over the sea bed, and whilst the sounding survey would define the sea bed contours, and perhaps locate certain obstructions, it would not disprove the existence of any others. Consequently, where such obstructions are suspected, the area must be swept to a given depth below datum which can then be considered free of obstructions. Civil engineers, on the other hand, even if interested in safety clearances for shipping, often wish to know the whereabouts of any obstruction rising more than x feet above the sea bed, and like the sub-tense pole the sweep has to be turned upside down and used in a different way. This sweep is essentially a thin wire towed by two vessels at a set depth, one of the vessels being fitted with a friction brake drum. The vessels steam slowly at about 2 to 3 knots on each other's beam, about 300-ft. apart, each having suspended from a suitable davit or gallows a calibrated and weighted tow-rope. Near the weight or sinker on each of these lines is a small block. The fine wire from the friction brake drum is passed through these two blocks and secured to the other boat. The operator on the friction brake drum can keep the wire taut and immediately feel any obstruction that may be encountered.



Survey boat fitted for sounding.

Hydrographic Surveying—continued

When such an obstruction is felt, he can slack away to prevent the wire parting, or should such a break occur the end can easily be wound in and repassed to the other boat. Any obstruction encountered can be marked and fixed for subsequent investigation as to least depth over, and extent of area. For the sweep to be set to a given depth below datum, the amount of tow rope paid out must correspond to the tidal level and angle of steaming. In sweeping from the bottom up the sinkers are dragged along the bottom and the small blocks attached to pennants shackled to the sinker. To maintain a full record of the area swept, the position of the control vessel should be fixed frequently and the bearing and distance of the other boat observed. In the control vessel, the surveyor must fix and plot the position to maintain the desired track by compass course. Simultaneously, when position fixes are taken, a bearing of the other boat should be obtained by compass and the distance taken by a vertical sextant angle. This information can be plotted and the area swept can be seen at a glance so that sweeping operations may be controlled to maintain a satisfactory overlap.

Current analysis is perhaps the requirement with the most pronounced difference in the two types of surveying. Again, the navigational requirement is to know the effects of currents upon shipping, and consequently observations at a near-surface depth of the current direction and velocity are usually made in selected positions covering a complete tidal cycle both at springs and neaps. The civil engineer, particularly when analysing results for the study of thermal problems or silt movements, must have accurate directions and velocities at different steps in depth and covering all states of the tide. Thus the observations he requires are considerably increased and can only be obtained by using a recording type of current meter. This meter can be lowered progressively to each step in depth for a short length of record to be taken. On completion of this ladder it can again be repeated at frequent intervals.

Float observations are another requirement of the engineer, and it is often necessary to release a number of floating targets and to follow them, plotting their positions until such time as they leave the area concerned.

Other civil engineering requirements not usually associated with navigation are tests for the amount of silt in suspension, cores of the sea bed obtained by boring and water samples for chemical analysis.

Port Health Authorities

National and International Obligations

T. L. MACKIE, M.B.E., F.R.S.H., M.I.N.A., M.S.I.A.*
(Chief Inspector, Port of London Health Authority)

THIS century has been one of real international collaboration in the sphere of public health and the establishment of a recognised centre to control international organisations that disseminate knowledge. The most remarkable achievement of these organisations, particularly that of the most recent, the World Health Organisation, has been the drafting of the International Sanitary Conventions which have been ratified, with some minor exceptions, by all the countries of the world. This wonderful success has demonstrated a wealth of international understanding and goodwill, and it is perhaps a matter of regret that this field of international co-operation has not received as much widespread publicity as it richly deserves.

I. Historical Evolution of Quarantine

It may be of some interest to review the sequence of events leading onwards from the early conceptions of preventive measures and those adopted in efforts to halt the importation of infectious diseases, nowadays better known as communicable diseases.

Although it has been recognised since time immemorial that certain diseases spread from man to man and from other sources to man, it was not until the middle ages that any really serious attempts were made to control the spread of diseases into seaports and the hinterlands and those attempts were mainly directed towards bubonic plague. Despite all the precautions taken, bubonic plague did invade Europe in the fourteenth century and, in its sweep, took toll of a considerable portion of the population to the extent of at least one-third in England.

The Venetians of those times, who were prominent sea-traders with the East, decided to implement laws and operate a maritime quarantine station, most probably the first in the world. This example was subsequently adopted by other seaports and a substantial part of the quarantine demands imposed on men, ships and cargoes, have served as a guide for quarantine regulations until comparatively recent times.

So far as England was concerned, although certain measures were introduced in the middle of the seventeenth century, it was not until early in the next century that Parliament passed an Act for establishing the practice of quarantine; thereafter, a number of Quarantine Acts were passed which imposed specific penalties on ships arriving from various overseas ports. Of these Acts, the last came into force in the year 1825 and remained in force until repealed by the Public Health Act, 1896.

While the principles of quarantine were upheld in this country, a practice of medical inspection was substituted for foreign arrivals and the ships and crews were to be dealt with according to health conditions prevailing during the voyage. These functions were executed by H.M. Customs at the various seaports to which Quarantine Medical Officers were attached. Eventually, the Public Health Act, 1872, empowered the Local Government Board to constitute Port Sanitary Authorities with assigned powers which were practically limited to the detection and isolation of the more dangerous communicable diseases. Thereafter followed the more decisive statutory instrument contained in the Public Health Acts of the year 1875 and 1891, which added considerably to the powers and scope of the then known Port Sanitary Authorities to inspect premises and vessels within their districts.

During the lifetime of the Quarantine Act, 1825, it was noted that quarantine measures carried out at ports in the various countries were not consistent and differed considerably in some comparisons, the practices having been based on meagre scientific knowledge and, no doubt, in some cases influenced by local circumstances. In the hope of reducing some of these variations, the first International Sanitary Convention was drawn up by representatives of nine foreign governments in the year 1851. Unfortunately, this was not a success owing to the divergence of opinions concerning the origin and causes of the principal communicable diseases, but it did prove itself to be a portent of more successful efforts that followed.

II. Development of Obligations

It is abundantly clear that from the earliest conceptions of Port Sanitary Authorities it was the singular intention to provide the nation with an organised defensive system at the seaports to protect the population of the United Kingdom from dangerous communicable disease liable to be imported through the maritime commerce involving crews, passengers, ships and merchandise.

As it so happened, there was directed towards sanitation a revival of thought sweeping through the country and legislation imposed responsibility upon the newly constituted Port Sanitary

* Paper (slightly abridge) delivered at the 63rd Annual Conference of the Sanitary Inspectors' Association—September, 1956. Reproduced by kind permission.

Port Health Authorities—continued

Authorities for the abatement of nuisances within their districts being those prejudicial to health, whether ashore or afloat. Undoubtedly, there was wide scope for hard work and enthusiasm for those pioneer Medical Officers and Sanitary Inspectors.

With the relatively intolerable sanitary conditions of crew accommodation found aboard most merchant ships and similar observations about the ports, it is difficult to imagine how those few officials were able to make any impression at all.

The problem of dealing effectively with the ever-moving shipping industry and the stationary shore establishments is a peculiar aspect of port sanitary administration. Overseas commerce is a vital factor in the nation's economy and the ports feed our national larder, therefore, it becomes a logical obligation upon the sanitary administration to function as effectively as possible without unduly impeding the flow of trade. All who have served in this field must have experienced, at some time or other, the intricacies associated with expedient decisions. As time proceeded, the sick were isolated, disinfection effected, gross infestation of vermin were treated and sanitary defects reported. With limited facilities at their disposal and somewhat meagre scientific knowledge, the appointed "guardians" plodded slowly forward doing their best to honour the trust reposed in them.

This era may have been one of tough and humble beginnings, fraught with mistakes and frustrations, successes and failures, but time was helping, advances in medical and sanitary sciences were soon forthcoming and the prestige of the Port Sanitary Authority was increasingly acknowledged, with a corresponding decline in operational resistance.

As a first principle it was the duty of the Port Medical Officer to intercept any disease or suspicion of disease and to enforce his invested powers to prevent it being communicated to the public at large. Coinciding with this action, the Officer of H.M. Customs was assigned the power to withhold "pratique" from any arriving ship until the Port Medical Officer was satisfied and, pending this assurance from him, the ship could be denied any contact with the shore to the extent of being isolated at the approved buoys for a period of "quarantine." To carry out this procedure effectively, it was incumbent upon the Port Sanitary Authority and H.M. Customs to work in the closest harmony.

In those earlier times, the Port Medical Officer was scarcely helped by the customary "Bill of Health," a document which purported to give correct information concerning the health conditions existing at the previous port of call. Those documents were not always as reliable as they appeared impressive. International communications did not cover such a global network, so the Port Medical Officer in the United Kingdom framed his conclusions on the knowledge he gained aboard the arriving ship.

The constituted Authority was required to provide means for transport and the isolation of patients suffering from infectious diseases, together with their contacts, who were to be detained for an immediate period of surveillance, in addition to a reliable steam disinfector installation to sterilise infected bedding and clothing. It was the duty of the Sanitary Inspector to execute instructions from the Port Medical Officer and carry out inspections of the district and ships therein for the purpose of controlling nuisances.

During the past seventy-five years, attention has also been directed towards the international aspect of the subject on both sides of the Atlantic involving representative bodies of European countries and the Pan-American Sanitary Bureau. This international co-operation and advanced scientific knowledge, accrued from the field and laboratory, laid the foundations of the International Sanitary Convention, 1926, which was agreed and signed in Paris on behalf of sixty-six countries and ratified later by no less than forty-four of them.

The stage was apparently set for further advancement. The volume of air traffic was intensifying and in the year 1933 a comparable code of practice for airports was drafted as a Convention and presented for signature at the Hague. Unfortunately, only a few countries including United Kingdom appended their signatures to this Aerial Navigation Convention, 1933, which set the pace for public health control at airports.

In order to give further effect to the International Sanitary Convention of Paris, 1926, and consolidate certain other regulations in force at the seaports, new regulations became statutory and titled as The Port Sanitary Regulations, 1933, to be exercised by all Port Sanitary Authorities in the United Kingdom.

Subsequently there came into being the Public Health Act, 1936, to bolster public health control in the national sphere. Later the International sphere received further stimulus as a result of the Fourth World Health Assembly in 1951, when the International Sanitary Regulations, 1951, were framed and which form the basis for port health regulations in the principal countries of the world, including those of the United Kingdom, entitled The Public Health (Ships) Regulations, 1952, and The Public Health (Aircraft) Regulations, 1952. Here, then, are assigned powers of public health control, which together with others of a national order, provide seaport and airport authorities in the United Kingdom with the fruits of more than one hundred years of concentrated efforts, wisdom, scientific investigation and displomacy to eradicate the causes and prevent the spread of diseases, especially those communicable to men. Altogether they do not offer a panacea for every problem in detail, nevertheless they do have far-reaching influence in practice and are proven to be very useful weapons in the defensive armoury of health.

(a) The National Aspect.

Quite apart from local by-laws, the main functions are governed by legislation for preventing the importation and spread of infectious diseases, controlling nuisances and other conditions prejudicial to health, the examination of imported foods destined for human consumption, the prevention of damage by rodents and the control of shellfish layings.

Since there are 91 Port Health Authorities and many Riparian Authorities, all functioning with the status of Local Government and responsible for preventing the importation of infectious diseases from overseas into the United Kingdom by sea and air, it is to be expected that there are variations in the application of the law relating to these measures, and therefore, a generally acceptable procedure adopted by a major port such as London is selected for this purpose and similar reference made to a major airport.

As a ready guide to Port Medical Officers, the Ministry of Health issues a confidential Weekly Record of Quarantinable Diseases regarding the prevalence of Plague, Cholera, Yellow Fever, Smallpox and Typhus Fever throughout the world, with special reference to ports, thereby enabling Port Health Authorities to make advanced preparations for arrivals from any of the mentioned "infected" or "suspected" areas.

(i) **Declaration of Health.** Additional information is also required from all foreign-going ships in advance of arrival, excluding those from "excepted" ports, which means any port situated on the European coast of France, the coast of Belgium and Holland, or that part of the coast of Germany between Holland and the River Elbe, including the east side, Hamburg and any place in Kiel Canal.

While yet outside the limits of the port, the Master of the ship is given an official form titled "Maritime Declaration of Health" by the boarding pilot. On this form he is required to answer six direct questions appertaining to health conditions during the voyage and the present state of health of passengers and crew. He must also submit information about any death which may have occurred during the voyage and give particulars concerning every case of illness in detail. In addition to other questions relating to the ship, he must also supply information about the International Deratting Certificate borne by the ship. Health conditions are not confined to the passengers and crew, but with any unusual mortality among rats which may be aboard. A list of ports of call from the commencement of the voyage with dates of departure must also be declared and the completed form signed by the Master and, where applicable, countersigned by the Ship's Surgeon in readiness for the boarding Port Medical Officer on arrival at the port. Failure to comply and/or any other circumstances unacceptable to the boarding Port Medical Officer would deny the ship entry into the port, or, in maritime expression, "pratique" would not be granted. It is at this stage, where a strict control is exercised by night and day, that the Port Health Authority discharges its first national obligation.

Medical inspection routine is applied as necessary and expeditiously as possible; a ship may be directed to an isolated anchorage

Port Health Authorities—continued

for quarantine control; infectious patients and contacts, together with bedding and personal effects, may be speedily transported to the isolation hospital and all relevant information communicated directly to the Medical Officer of Health and Sanitary Inspectors at the terminal docking district.

There still remains one possible loophole in the defences of an "infected" ship when the apparently healthy crew and passengers are allowed to leave. This is acknowledged by using a surveillance system, whereby the Medical Officer of Health of the destination is notified immediately of the circumstances and official arrangements concluded to check the movements of the persons concerned for a stipulated time. Hereafter, the ship is actually "under control" until she has left the port, for the Port Medical Officer has far-reaching powers which enable him to deal with diseases and conditions associated with them aboard.

Owing to the rapidity of global air travel and the expanding volume of passenger traffic, a vigilant health control is imperative at airports. A modified, but comparable system is adopted by the "responsible authority," requiring that an official form known as the Aircraft General Declaration, which includes a portion relating to health, shall be completed and signed by the Captain of the aircraft and produced for inspection immediately on arrival. This part is carefully checked and any unusual information is promptly attended to by the Airport Medical Officer.

In order to clear passengers with a minimum of delay, three factors are taken into consideration; the existing health conditions, the areas contacted during the voyage and measures to adopt for surveillance and advice towards the persons who are freed.

It is a general principle to hospitalise patients and carry out the necessary disinfection of articles. Apparently healthy persons who arrive from "infected" or "suspected" areas are provided with printed cards which advise the course of action to be taken should any symptoms of illness be experienced after being freed. Those who are not ill, but who have been fellow passengers and contacts of an infectious case, may be detained for surveillance in hospital or may be freed to report to the Medical Officer of Health at their actual destination, who is immediately informed of the circumstances.

As with maritime procedure, there are "excepted" areas taken into account applicable to aircraft, and an international agreement exists nulifying the requirement to complete a formal health declaration for aircraft plying between countries of the Brussels Treaty Powers, since these countries are normally free from the quarantinable diseases This agreement can, of course, be waived by any of the administrations should abnormal circumstances of disease prevail in any one of them.

Of the quarantinable diseases, there are only two—smallpox and plague — that have a reasonable chance of eluding the health administration at the ports. Both are constantly in the minds of the Port Health Authorities and all possible safeguards are adopted to prevent smallpox being introduced by an air traveller in particular and plague by ship-borne rats.

All ships, whether foreign-going or not, are under health control while they remain within a port health district.

The power to deal with diseases aforementioned and the power to dismiss any recalcitrant ship from the port are only part of the measures exercised by the Port Health Authority. Almost immediately on arrival at the terminal berth, the ships are visited by a sanitary inspector who maintains intimate contact with them henceforward, attending to special instructions from the Port Medical Officer and executing his legal functions calculated to prevent any possible spread of nuisance or diseese from ship to shore. In so doing, the Port Health Authority discharges its second national obligation.

(ii) **Sanitation.** In this connection, the role of the Sanitary Inspector is second to none in importance and scope for activity. By his vigilance and adherence to responsibility, he is able to apply strength and stability to the health defensive system. Acting in accordance with his statutory authority, he implements the provisions assigned to him in the public health enactments, controls pest infestations and promotes improved environmental sanitation ashore and afloat. There is no real limit to the extent in which he is able to serve in this vocation, even to the point of educating in the principles of hygiene, by precept and example.

In addition to creating environmental health conditions conducive to the well-being of the residents ashore, it is the responsibility of the Sanitary Inspector to carry out a comprehensive sanitary inspection of every merchant ship and officially report any deficiencies that are nuisances or injurious to the health of crew or passengers. The right to do so is provided in the Public Health Act, 1936, where, for the purpose of exercising appropriate sections of the Act, a ship is deemed to be a house and the Master to be occupier thereof. Only ships commanded by an Officer bearing H.M. Commission and those belonging to a foreign government are exempted. Odd though it may appear to be, nevertheless, merchant ships of foreign nationalities are subject to the same degree of legal treatment.

Nuisances and unhealthy conditions, whether borne by the air, on the water, or about premises, come within the purview of the Sanitary Inspector's duties. Nor can human welfare be wholly detached from this sphere of responsibility, which demand that infestation of social insect pests, rats and mice, be exterminated or, at least, regularly controlled, while there is also a moral obligation to co-operate with other official organisations in the suppression of industrial insect pests. All these pests, many of which are active saboteurs of the national economy as well as vectors of diseases communicable to man, respect no boundaries, therefore, all shore premises and every type of vessel in the port is a potential source of infestation and transmission of disease which necessitates some organised and systematic inspection of them all.

Fig. 1. Sanitary Inspector boarding a ship.

Coasting ships are issued with Rodent Control Certificates that are valid for four months, provided that they comply with the conditions set forth in the Order.

Complete rodent control in the ports is not confined to organised extermination alone. As previously mentioned, the fear of importing plague is one of the essential features in the defence of the nation's health and the precautions taken are complementary. Primarily, as far as practicable, no ship-borne rats from ports where plague is endemic are allowed to escape ashore and, secondly, the reservoir of rats populating the shore is reduced to a minimum. Every effort is made to recover specimens from ships and from warehouses and wharves for the specific purpose of checking by bacteriological examination. Particular attention is paid to any rodent which is moribund or found dead from natural causes.

Not least among health precautions taken is the investigation of the drinking water supplies. Since most ships replenish the water storage tanks from supplies at various foreign ports and because this drinking water is available to all who board the ship, it is a desirable practice to take routine samples with reasonable discretion and submit them for examination. In extension of this protection afforded to those whose business takes them aboard the ships in port, routine samples are taken of the port fresh water supplies to the ships, some from licensed water-boats and others from the quay hydrants, to ensure the health of the seamen and thus the operational efficiency of the outward bound ships.

(iii) **Food Inspection.** Nothing here is intended to elaborate upon the great volume and increasing variety of foods for human consumption that are imported into the United Kingdom. In consequence of the freedom from governmental control the added burden of vigilance and inspection has fallen heavily on the staffs

Port Health Authorities—continued

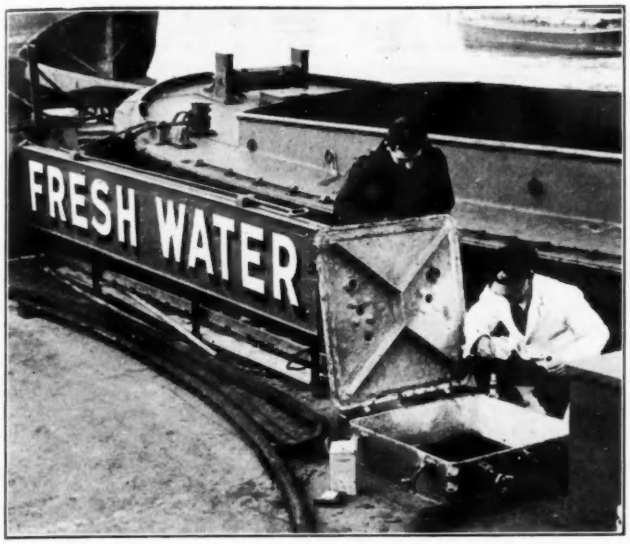


Fig. 2. Sampling fresh water supply.

of Port Health Authorities. The initiative of private enterprise harnessed with the wider ranges of food processing techniques has provided an added attraction for the Sanitary Inspectors. Furthermore, the recent discoveries of certain antibiotics and anti-oxidants which are being considered for the preservation of meat and other foods also require unrelenting attention at the importing centres.

This branch of the Inspector's duties is rather more spectacular in some respects, one of which is the inevitability of becoming involved in the complex organisation which handles and distributes the vital food supplies to the nation, and another is the ever-present possibility of exciting the sensitive world of commercial finance. In controlling such vast quantities of imported foodstuffs there is obviously need for a reasonable standard of specialised knowledge, especially where fresh meat, fish, fruit and vegetables are concerned, and, in all circumstances, diplomacy and tact are an asset. As far as practicable, the law is applied, but it is generally used as a guide and seldom as a threat. The basic principle of the legal aspect requires that foostuffs destined for human consumption must be intercepted if found to be, or suspected of being unsound, unwholesome, diseased or unfit for that purpose and official detention, sampling or seizure may be applied accordingly.

In order to reduce the burden of complete inspection, meat is allowed entry into this country for human consumption on condition that each parcel bears the replica of an approved "official certificate" from the country of origin. If the obligations of the exporting country are meticulously carried out, only deterioration or damage would engage the attention of the Inspectors here, but such satisfaction is not entirely realised and, therefore, both superficial and a reasonable percentage detailed examination is imposed on consignments according to routine and experience.

However, nothing is wasted as a total loss, because all condemned foodstuffs are diverted under formal written guarantees to other useful purposes such as animal feed, fertiliser or industrial uses.

Sampling of selected type of other commodities is a routine measure in order to check colouring and preservative substances or any other matter injurious to health. To what extent the foodstuffs are held in detention pending the report of the Public Analyst depends on the overall circumstances and also by approved arrangemeans with the custodian of the foodstuffs if the detention should exceed forty-eight hours.

Quite appropriately, only the principle obligations have been brought into focus appertaining to ports of a general character, and nothing mentioned about the major fishing ports where vast quantities of fresh fish are imported and inspected by the Sanitary Inspector, in addition to other normal port health duties.

(b) **International Aspects.**

The amazing expansion, popularity and ramifications of modern international travel facilities, having drawn otherwise distant countries so closely together, has made it almost impossible to differentiate national and international basic principles for the preservation of human health. In the present circumstances, all countries are becoming more sensitive to health conditions prevailing in any other and, if only for this reason, it has become necessary to establish the International Sanitary Regulations, 1951, as a climax to serious thought for the eradication of disease and to limit the spread of any outbreaks. Under the directions of the state health administration, the implementation of the requirements has fallen to the lot of the seaports and airports of all the ratifying countries, and it is the duty of the health administrations to ensure that their obligations are fulfilled at the ports, thereby creating uniformity of practice on an international scale imposing a minimum of interference with world traffic and human welfare.

The Regulations comprise the fullest details of the needs and agreed procedure for controlling the five quarantinable diseases, but it will probably suffice to mention only some of the outstanding requirements briefly:—

(1) The health administration must notify the W.H.O. of any outbreak of disease and supply relevant information concerning evidênce of disease.

(2) The health administration, as far as practicable, shall ensure that seaports and airports shall have at their disposal organisation and equipment sufficient to apply measures provided for in the Regulations.

(3) Each health authority to keep rodents in the port to a negligible number.

(4) The health administration shall ensure that a sufficient number of ports in the country are adequately staffed for inspection of ships and proper arrangements provided for the deratting of ships. Ships in foreign trade routes must be inspected and/or deratted at least every six months and appropriate International Certificates issued by the health authority.

(5) The health authority shall employ all means in its power to diminish the danger from the spread of plague by rodents and their ectoparasites.

(6) The health authority for a seaport or airport may subject to medical examination on arrival any ship, aircraft, or any person on an international voyage and any person before departure on such a voyage. Sanitary measures may also be applied accordingly.

These, of course, are in some respects additional to those already embodied in the national public health regulations, which justifies the contention that both aspects are interdependent.

Fig. 3. Dock-side inspection of imported meat.

Port Health Authorities—continued

It is noteworthy that the Regulations allow sanitary measures to be applied by the health authority where deemed necessary in connection with the health conditions aboard foreign-going ships. This power to make sanitary inspections and apply sanitary measures has been established practice in the national interests since the inception of port sanitation in the United Kingdom and probably reflects the participation in the constituting of the Regulations.

Apart from the strict enforcement of the medical provisions and associated organisation, there is no difficulty in appreciating the wisdom of drastically controlling rodents. The effect has been to provide a complete denial to the widespread belief that "all ships are more or less ratty." On the contrary, only a small percentage of ships now harbour any more than a negligible number, and this result is proving to be a blessing to all associated with maritime commerce, especially when considered in the light of the menacing infestations that were ship-borne before effective control was introduced. In extension of the rodent control measures carried out for national security, these Regulations require a complete inspection at specified intervals of six months and extermination action where found necessary to reduce the infestation to the prescribed "negligible number." Furthermore, rat-proofing is not only to be encouraged but officially recorded on the certificate issued subsequently. The certificates must conform with the specified model, although there are two forms of issue.

When an empty ship is inspected and the evidence discovered clearly indicates that there are rodents present in excess of a negligible number and the ship is not in possession of a valid certificate, then the ship is required to undergo a deratting operation to satisfy and be supervised by the port health authority and, on completion, the ship must be granted an International Deratting Certificate recording full details of the operation in the prescribed manner. If, in similar circumstances, or if the holds contain only ballast or other material, unattractive to rodents, of such a nature or so disposed as to allow a thorough inspection of the holds and it is concluded that any rodents present are negligible in number, only then will the ship qualify to be granted an International Deratting Exemption Certificate recording the full details of the inspection.

This unprecedented measure to eradicate rodents harbouring in the international maritime transports, applied in conjunction with the organised control of rodents in and about port installations, has very considerably reduced the transmission and threat of plague.

Any real hope of international uniformity and success in connection with health protection procedure must surely take into account the need for personal contacts with those responsible for the administration and execution of the Regulations in order that there might evolve a common understanding of applied procedure and an appreciation of any particular difficulties. To this end, it is inevitable that those engaged in the less developed ports of the world should have the opportunity to visit and to receive instructions at the more advanced ports. For many years it has been the privilege and accepted obligation of port health authorities in this country to give both theoretical and practical instruction to selected doctors and sanitarians from overseas health administrations.

Is their training centre wisely chosen? Here they see the progressive procedure keeping pace with the advancing knowledge of the causes of disease and the applied technique for preventing its extension as well as the execution of statutory obligations without unnecessary flourish of power and officialdom. They see proven evidence of the belief that a port health service can be efficiently organised with a minimum of inconvenience and frustration to international commerce, such organisation being neither extravagant nor mean, but carefully adjusted to meet the national and international requirements; also where a port health authority is so well organised for boarding any infected or suspected ship in advance of her arrival and actually initiate the full-scale port health practice while at sea, thus enabling advanced preparations to be made at the port for the safe and smoother entry of apparently healthy passengers, crew and ship.

Finally, they see with what diligence the deratting operations are carried out to warrant, without question, their faith in any recording certificates issued in this country, a salient point in favour of the British shipping industry, with its numerous ships on international trade routes.

III. General and Conclusion

It is generally accepted that the magnitude of the tasks involved cannot be entirely assessed statistically, but some guidance is obviously afforded in this respect. Details are published annually by all Port Health Authorities and an indication may be found from some figures taken recently from an annual statement referring to the Port of London.

Number of Ships arrived from foreign ports	15,452
Number of Ships arrived from coastwise ports	11,882
Number of Passengers arrived from overseas territories	99,230
Number of Infectious Cases intercepted on arrival	130
Number of Sanitary Inspections on ships from foreign ports ...	9,973
Number of Ships with Sanitary Defects officially corrected ...	1,067
Number of Rodents destroyed on ships (Rats)	3,205
Number of Rodents destroyed on ships (Mice)	803
Number of Rodents destroyed ashore (Rats)	2,512
Number of Rodents destroyed ashore (Mice)	3,836
Number of Ships granted International Deratting Certificates ...	156
Number of Ships granted International Deratting Exemption Certificates	1,044
Number of Ships granted Rodent Control Certificates	103
Number of Shore Premises permanently controlled in scheme ...	1,500

Amount of Foodstuffs arrived—4,200,000 tons.

Amount of Foodstuffs condemned as unfit for human consumption—5,048 tons.

Numerous minor Sanitary Defects promptly corrected ashore and afloat by verbal arrangement.

London Airport.

Number of Planes arrived from foreign airports	30,741
Number of Passengers arrived from overseas territories	919,593

(a) **Remarks.**

An attempt has been made to recapture the historical drama of early quarantine measures instituted with the best intentions of defending human health and welfare from the ravages of diseases, the causes of which so little was known and likewise the cure, then to contrast the old Quarantine Service with the new Port Health Authority. The imagination and wisdom of those early pioneers served a useful purpose, if only to guide future generations to ultimate success. In making this contrast with the present-day organisation and the high degree of security enjoyed by the nation against these dreadful diseases, there must inevitably develop a sense of gratitude towards those who have contributed to this victory over the centuries and no less to those of our own country even in recent years.

There has been no intention of amplifying any other than the main functions of present procedure in covering the obligations imposed and it may be freely accepted that there are many minor duties and also that much is achieved off the official record by verbal arrangement. This is indeed a unique service and calls for Sanitary Inspectors with the appropriate knowledge and personality peculiarly adaptable to the marine world.

Both types of port health authorities bear a great responsibility that could not possibly be so efficiently discharged by so limited a staff without the invaluable aid rendered by co-existing organisations, including H.M. Customs and the Immigration Officers, who also participate in documentary and personal scrutiny on arriving ships and planes.

Except for a few specific features outlined in the International Sanitary Regulations, the national and international obligations are based upon the same principles, which are governed by interwoven legislation so far as physical and environmental health are concerned. Legal provisions are of paramount importance since they are in fact the very core of the statutory obligations and, therefore, effectively influence the entire value of port health activity. So far as the international aspect is concerned, there seems no reason for criticism at present, but there are some points for suggested criticism at home.

It is suggested that certain applications of the Public Health Act to shipping might be considered:—

(a) Is it right and proper that British law should govern the standard of sanitation aboard merchant ships of other nationality in circumstances which do not affect the health and welfare of the British people?

(b) Is it reasonable to consider a ship as a house in the sense of sanitary control?

Port Health Authorities—continued

(c) Is it reasonable to allow a ship to demand 24 hours' notice of sanitary inspection in all knowledge that ships are moving houses?

(d) The exemption granted to ships belonging to a foreign government implies that merchant ships of totalitarian states are exempted?

also: The Port Health (Ships) Regulations, 1952, Article 18 (1) requires certain boarding restrictions until the ship is free from control under the Regulations. When is the ship free from control under the Regulations?

Clarification of these points would do no harm to those who seek to satisfy their national obligations.

Before passing from the subject of sanitation in ships, it may be fitting to refer to the improved standards of living accommodation afloat. For our own Merchant Navy, many contributed efforts have been made by port health authorities to improve the living conditions of seafarers, although very few have caught the light of publicity. It is not in the dim and distant past that many of our ships were "slums of the sea" at a time when the persistent efforts to raise standards, whether with legal support, by persuasion or suggestion were reluctantly acknowledged. For no other motive than to fulfil a national obligation the port health authorities continued their pressure, although the actual transformation has been channelled through other organisations. For some reason, the fact that better living standards would promote the happiness of the ship and that a happy ship is an efficient ship did not appeal to those who controlled the ships; yet, in no other industry is so valuable an asset as a laden ship entrusted to so few men and in such hazardous circumstances. How, then, could these men be expected, except by noble tradition, to honour their responsibility seriously, even to the extent of injury or death, if they were unhappy as a result of their health and welfare being ignored?

Inferior standards in the transport, handling and storage of crews' foodstuffs has also been singled out for special attention by the port health authorities because of the too frequent disregard of the contamination and wastage by organisms and insect pest infestations. A few comments concerning the much greater task of imported foodstuffs.

It has become almost common knowledge that there is an urgent need for more uniformity in food inspection at the ports if the national obligations are to be met effectively. This has been emphasised quite recently by the imported Chinese egg albumen dilemma. Of course, there are many reasons why some approach to uniformity of action is very desirable while there are so many alternative ports from which the food importer can choose.

There is also a need for certain modifications in the Imported Food Regulations:—

(1) To extend the definition of "animal" to include the horse.
(2) More flexibility in the time limit of detention of foodstuffs being held for examination and/or sampling.
(3) Clarification of Eire as an exporting country of meat.

In addition, there is always a need to challenge the validity of the "bulk" Official Certificate, and last, but by no means least in the light of some recent unpleasant surprises, the value of the affixed Official Certificate.

It must be anticipated that in this particular branch of public health service, the port health organisation must be alert to ever-changing circumstances and the obligations are not confined to health and welfare but, if the best results are to be achieved, the range must include education by personal contact or appropriate literature.

Reference has been made of the valuable contacts with overseas visitors to our ports for expanding their knowledge of the organisation here. Is it too much to suggest that an occasional reversal of this wise policy in particular circumstances could stimulate and educate the Sanitary Inspectors of our ports to the advantage of this important service who faithfully carry out the national and international obligations?

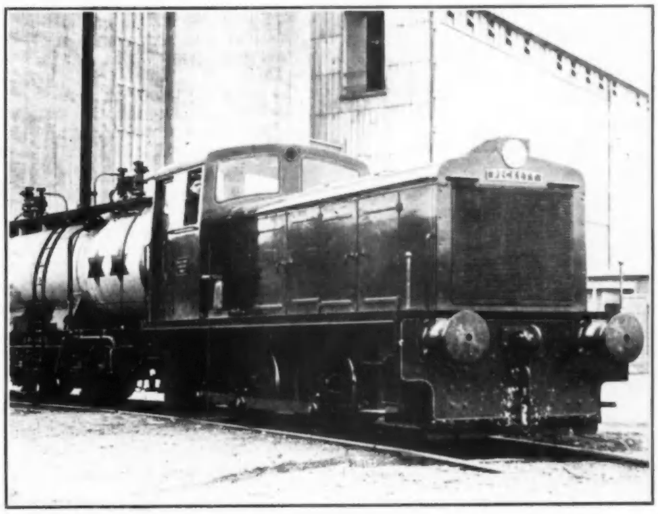
There is indeed no room for complacency in an active port health district, neither must Sanitary Inspectors allow themselves to drift into the role of mere "Sanitary Policemen" if the torch of progress is not to be extinguished, nor should the existing organisation for health control at the ports be established as the final development in national efficiency.

Manufacturers' Announcements

New Shunting Locomotive

The first two prototypes of a new design of diesel-mechanical shunting locomotives have recently been produced by Peckett & Sons Ltd., of Bristol. For the first time a fully automatic mechanical transmission has been developed for locomotive work, offering the ease of control of an electric or hydraulic system coupled with a high transmission efficiency and simple robust parts.

The locomotive which is nominally of 200 h.p. has an overall weight of 32 tons and an overall length of 20-ft. 4-in., with an 0-4-0 wheel arrangement and a wheelbase of 5-ft. 6-in., which allows it to traverse a minimum curve of 50-ft. radius. The wheels, of 3-ft. 2½-in. diameter, are driven by connecting and coupling rods from a jackshaft at the rear end. The engine, gearbox and auxiliaries are mounted under a bonnet which has four access doors on either side and large double doors in the roof to facilitate engine maintenance.



The locomotive has a top speed of 13¾ m.p.h .and a fuel capacity of 220 gallons. The bottom gear tractive effort is approximately 19,000 lbs. There are four gear ratios which can be varied to suit particular applications, with corresponding variations in the maximum speed and tractive effort. The two prototype locomotives differ in that one is fitted with a Gardner type 8L3 engine developing 204 b.h.p. at 1,200 r.p.m., and the other with a Crossley type EST 4 developing 220 b.h.p. at 750 r.p.m. By means of a different ratio in a pair of transfer gears the input shaft of the gearbox is in both cases driven at a maximum speed of 1,200 r.p.m. In all other respects the two locomotives are similar. The design has been arranged so that other well-known makes of Diesel engine can also be accommodated.

Control of the engine is achieved by two levers only, the throttle and the reversing lever, the gear changes being automatic. The design of the gearbox, however, permits of an over-riding manual gear lever being fitted, which will give positive engagement of 1st, 2nd or 3rd ratios.

Cathodic Protection in Tankers

Further orders for the installations of "Guardion" cathodic protection in 10 ships of the super-tanker category operated by the Niarchos group have been received by F. A. Hughes and Co., Ltd., London. Of these the world's largest tanker operating solely in the carriage of petroleum products, the Spyros Niarchos, has already been equipped and work is proceeding on other tankers now building in Japan.

This development, it is stated, is a significant indication of the positive steps now being taken to reduce corrosion damage in cargo-ballast compartments and in turn maintenance and renewal costs. Whereas four years ago only one ocean-going tanker operating under the U.K. flag was fitted with cathodic protection the total to-day is well over 100.

APPOINTMENTS VACANT

SHIPBUILDERS in the South-West now expanding to build up to 60,000 tonners and with full order book require services CHIEF EXECUTIVE with possible seat on the board. Applicant must have had previous senior administrative experience and have built large ships. Salary starting £4,000/£5,000 with participation profits. State post now held, previous experience, age and fullest details. Only really top men should write in strictest confidence to Chairman, Box DHA 246 LPE, 55, St. Martin's Lane, London, W.C.2.

DESIGN ENGINEERS (Senior and Assistant) required shortly by Civil Engineering Contractor with Head Office near Victoria Station. Experience in design of Marine Structures, Docks and Retaining Walls essential. Some knowledge design industrial structures desirable. Assistants should have some detailed knowledge of utility services. Write in confidence to Personnel Manager, Box DHA 226, L.P.E., 55, St. Martin's Lane, W.C.2.

MERSEY DOCKS AND HARBOUR BOARD

Applications are invited for the position of Assistant Engineer-in-Chief to the Board, initial salary £3,000 per annum.
Candidates must be Corporate Members of the Institution of Civil Engineers. Applicants should state their age, giving full particulars of their career. It is desirable that they should have experience in dock and harbour construction and maintenance. Apart from technical qualifications, which must be of the highest standard, first-class executive and administrative ability is essential for this most important post which carries the opportunity of succession to Engineer-in-Chief.
The person appointed would be, after the usual interval, subject to the Board's full Conditions of Service, which include a superannuation scheme.
Applications should be received by the undersigned not later than 30th November, 1956, and marked "Assistant Engineer-in-Chief."

Dock Office,
Liverpool, 3.

FRANCIS H. CAVE,
General Manager and Secretary.

D.S.I.R. require Assistant Experimental Officers at the Hydraulics Research Station, Wallingford, Berks: (1) CIVIL ENGINEERS for hydraulics research, including work on models. (Ref. E206/6A). (2) MATHEMATICIAN for analyses of hydraulics problems and related computation work. (Ref. E207/6A). Qualifications—G.C.E. advanced level in two scientific or maths subjects, or equivalent. Over 22, pass degree, H.N.C. or equivalent generally expected. Salary range—£350 (age 18)—£755 (Men), £350 (age 18)—£675 (Women). Equal Pay Scheme. Five day week. Favourable housing prospects for married candidates Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting appropriate reference. Closing date 29th November, 1956.

NIGERIAN PORTS AUTHORITY has vacancies for TRAFFIC OFFICERS. They will be responsible for the day to day supervision of the working of the Quays and Warehouses at Apapa or Port Harcourt. Applicants must possess a sound practical knowledge of port working, including experience in all aspects of quay, shed and warehouse operating. They will also be expected to have had experience in:—

(a) Cargo documentation—(Import, Export, Customs, Claims Statistics, Rates and Charges).
(b) Use of mechanical appliances in the handling of goods.
(c) Economical use and distribution of labour to jobs.
(d) Ability to instruct and supervise staff.

These appointments call for energy, keenness and enthusiasm. They also call for a high standard of physical fitness.
The salary will be within the range £960—£1,230 (with Overseas Pay where appropriate between £240 and £270).
Appointment will be for one tour in the first instance. Thereafter subject to satisfactory service on a permanent basis. Non-contributory Pension Fund. Tours normally 12/18 months. Leave on basis of 7 days for every completed month of service. Free First-Class passages for Officer and wife. Additional passages and allowances for children. Furnished accommodation provided at reasonable rental. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M3B/43712/DU.

ASSISTANT CIVIL ENGINEER—design—previous experience on docks and harbours desirable. Age range 28 to 40. Salary will be based on experience and qualifications of the individual selected. The post which is in London with a professional firm in London carries prospects both as regards remuneration and variation of work. Box 194, "The Dock and Harbour Authority," 19 Harcourt Street, London, W.1.

GEORGE WIMPEY & CO., LIMITED

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QUALIFIED CIVIL ENGINEERS

for design and planning of a wide variety of interesting Engineering and Structural Projects.

Permanent Head Office appointments, pensionable after probationary period; 5 day week, 9.0 to 5.30; staff restaurant; modern offices.

Applications to:
Establishment Officer,
27 Hammersmith Grove, London, W.6
Ref. R.135A

PORT OF BRISTOL AUTHORITY

ASSISTANT ENGINEER (MARINE AND DREDGING)

Applications invited for above position in department of Engineer-in-Chief.

1. Candidates must have had considerable experience in marine and dredging operations, including:—

Repairs and maintenance of dredgers, hoppers, tugs and other floating plant;
Periodical and damage surveys of floating plant, including deep sea vessels;
Direction of employment of bucket, suction and grab dredgers and supervision of officers and crews;
Preparation of estimates and reports and conduct of correspondence relative to marine and dredging work generally.

2. Salary £1,295 x £55 to £1,515. Commencing salary according to qualifications and experience. Post superannuable; medical examination. Applicants must disclose whether related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

3. Applications, enclosing copies of recent testimonials, to me by 8th December, 1956,

Port of Bristol Authority,
Avonmouth Docks,
Bristol.

N. A. MATHESON, M.I.C.E.,
Engineer-in-Chief.

SUPERINTENDENT OF LIGHTS required by HONG KONG GOVERNMENT MARINE Department for appointment on probation to pensionable establishment. Normal tour 4 years. Salary scale (including expatriation pay and present temporary allowance): (I) Single men: £1,376 rising to £2,216 a year; (II) Married men without children: £1,514 rising to £2,425 a year; (III) Family men: £1,651 rising to £2,634 a year. Free passages. Liberal leave on full salary. Candidates, aged 28-35, must be A.M.I.Mech.E. or A.M.I.E.E. and have had 3 years practical experience with all types of marine navigational aids. They should also be conversant with R/T and W/T for port communications. Write to the Crown Agents, 4 Millbank, London, S.W.1 State age, name in block letters, full qualifications and experience and quote M2A/41846/DU.

HYDROGRAPHIC SURVEYOR required by contractor for work abroad. Applicants should write stating age and full details experience to Box No. 193, "The Dock and Harbour Authority," 19, Harcourt Street, London, W.1.

FOR SALE

NAVIGATING BEACON INSTALLATION consisting of 3 Gardner 5 kw. 110—165 v. diesel generators; 300 amp. hours NIFE battery; separate switchboards for generators and battery. Including revolving lens, stand-by equipment for gas operation and 4-LIEF-300 fog sound transmitters. Unused. Stored in Hong Kong. Full particulars on application to The Crown Agents for Oversea Governments and Administrations, 4, Millbank, London, S.W.1. (O/PROD 1652).

JULES WEITZ MONO-TOWER CRANE, Type 45. 98-ft. mast. 82-ft. fixed jib, maximum lift 4 tons. Complete with ballast, transformer, 100-ft. track. In new condition. For further particulars apply Grimley & Son, Chartered Surveyors, 39-40, Temple Street, Birmingham, 2. (Telephone: MIDland 5443).

WANTED

WANTED immediately a 30/35-ft. Launch/Tug, 60-100 h.p. Diesel engine. Decked with wheel house and small well. Towing bitts and boarding rails desirable, preferably steel hull. Box 192, "The Dock and Harbour Authority," 19, Harcourt Street, London, W.1.